



MiraCosta College Design & Construction Standards

VERSION 4.0

November 10, 2023



INTRODUCTION

INTENT

The following pages are intended to establish a set of Design and Construction Standards for new and renovation building projects for MiraCosta College. The minimum criteria for establishment of these standards are quality, maintenance, cost, location, energy efficiency, life cycle costs, and safety. The materials, products and criteria identified in this document have been determined by the MiraCosta College committee, MiraCosta's Construction Management Consultant, and the architects and engineers retained by MiraCosta to assist with this effort. It is MiraCosta's intention that the information contained herein be used on all new and renovation projects.

A campus Facilities Master Plan and Guidelines have been prepared that addresses overall design intent for the MiraCosta campuses. It is recommended that this document is referenced for design implementation criteria. These documents include:

- MiraCosta College Facilities Master Plan
 - Sustainability Goals & Guidelines
 - Technology Guidelines (Superseded by District Standards 4.0, Appendices 26, 27, 28)
 - Appendix
 - Utilities & Infrastructure Drawings
- MiraCosta College Space and FF&E Standards

PROJECT TEAM FOR STANDARDS

MiraCosta College

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This document has been assembled by the project team with input from various associated sources. It is intended to provide a frame of reference only and has not been researched for specific project conditions and

requirements. Therefore, each design and construction professional using this document should only do so for information purposes and should not rely that the products, materials and systems indicated will be the correct application and use for a specific building project. All design professionals are assumed responsible for their designs and specifications.

FORMAT

The information contained in this document is arranged using the Construction Specifications Institute (CSI) 36 Division format as a readily identifiable format for organization in the construction industry. This format will allow anticipated updates of this document in the future as new information is acquired and developed. The College shall continue to implement existing provisions of its construction standards which address the selection of materials and products. The College will continue to refine and update the standards to help ensure that these elements are adequately addressed during renovation and construction of new facilities on a campus-wide basis.

The outline developed for each CSI section is intended to convey the basic information for architects, engineers and design professionals to specify campus standard products, materials and building systems. This information includes a summary of the section scope, reference standards (also see complete list under the Division-1 heading), the materials and criteria for specification, distribution contacts (if any), special issues (if any), and special warranty information.

Catalog numbers and specific brands or trade names followed by the designation "or equal" are used in conjunction with material and equipment required by the Specifications to establish the standards of quality, utility, and appearance required. Wherever catalog numbers and specific brands or trade names not followed by the designation "or equal" are used in conjunction with material or equipment required by the Design Standards, it is intended that only the indicated items should be used.

The Appendix of this document includes supplemental information: Landscape Guidelines, and Campus Signage and Graphic Standards. These are provided for reference only and do not prescribe specific design solutions.

ADA ACCESSIBILITY

Many of the products and materials identified in these design standards are compliant with current disabled access requirements as determined by subject codes and laws. Other items are compliant but require the proper design implementation such as mounting locations, dimensional criteria, and placement. It is MiraCosta's intention that the campus maintains a barrier free environment providing equal access to all students, faculty, staff and visitors. As such, every effort shall be made in pursuit of this direction.

SUSTAINABLE DESIGN

MiraCosta College has developed District Sustainability Design Guidelines. Please refer to these guidelines in order to understand District established minimums and desired levels of sustainable design.

REFERENCE STANDARDS

Various reference standards have been used throughout this document in an effort to establish a minimum industry wide recognized basis for quality and reliability; a complete list of reference associations and industry standards are included in the Division-1 section. Although not specifically mentioned in each division, the design of new facilities and improvements to existing facilities shall follow at a minimum the criteria set forth in the following documents governing safety of materials and building systems. This list includes but is not limited to:

California Building Code (CBC)
Uniform Mechanical Code (UMC)
Uniform Electrical Code (UEC)
California Plumbing Code (CPC)



National Fire Protection Association (NFPA)
Occupational Safety and Health Administration (OSHA)
Americans with Disabilities Act (ADA)

The American Society for Testing and Materials (ASTM) is recognized as the industry standard for establishing the performance requirements for various building materials. The Design and Construction Standards recognize that adherence to the performance levels set forth in the nationally recognized standards of ASTM and the industry standards for design criteria, material performance and construction available through the various building trades, will do much to control quality levels while eliminating untested and unproven materials, products, and systems from consideration on future projects.

END OF SECTION



PROPRIETARY AND GENERIC SPECIFICATIONS, AND SUBSTITUTIONS

The criteria herein describe performance and quality characteristics that are the minimum acceptable quality levels required by the Owner and in some cases will list multiple manufacturers which may be chosen from. Substitutions of other manufacturers will be considered, provided, in the sole judgment and approval of the Owner, the proposed substitution meets the same standards of quality and design as described in these Design and Construction Standards. However, there are instances where the District has selected or designated proprietary systems or products that meet specific District performance requirements, allow for seamless integration into existing systems, provide ease of maintenance, and afford a lower total cost of ownership. In these instances, the Designer should include these systems and products. The District may consider other alternatives, but any alternative must satisfy the same requirements that the District has identified and are subject to District review and approval. **The following are Board of Trustees Approved Sole Source items. No substitutions will be accepted.**

Item	Manufacturer	Model #	Board Approval
Access control Boards	Lenel	(LNL2220)(LNL1320)(LNL1300)(LNL1100)	10/18/2018
Access control /Alarm Readers	HID	RP40 SE, Signo 20,20K,40,40K	10/18/2018
Auto Door Operator	LCN	Senior Swing 2800 and 9500 series	10/18/2018
Bosch Security Panel	Bosch	<ul style="list-style-type: none"> • B8512G – Small Building • B9512G – Large Building 	10/18/2018
Exterior Parking and Street Lights	CREE	LEDway STR-LWY	10/18/2018
Exterior Site lights	Selux	Quadro H2 LED	10/18/2018
Exterior Wall Packs	McGraw-Edison	ISC Impact Elite	10/18/2018
Fire Alarm	Notifier	(320)(640)(3030); Voice Evac	10/18/2018
HVAC Building Controller	Honeywell	Distech Jace EC BOS-8 JACE 8000 (w/Driver)	10/18/2018
Int/Ext. Lighting Control	Nlight	NCMPDT,NCMADCX,NPODM,NGWY2	10/18/2018
Interior Troffers	Lithonia	2VTL	10/18/2018
Mortise Locks	Schlage	<ul style="list-style-type: none"> • L9080EU • L9092BDCEU 06L RX (Reg) • L9492BDCEU 06A L583-363DM Plus L283-722 (Lactation / Gender Neutral) 	10/18/2018
Panic Locking Hardware	Von duprin	PA-RX-QEL-9947-NL-OP	10/18/2018

Item	Manufacturer	Model #	Board Approval
Wireless Clocks	Innovation	632402	10/18/2018
Wireless Clocks Transmitter	Innovation	101005	10/18/2018
Irrigation Controllers	Weathermatic	SL4800 w/SLM12-12 Zone Module	10/18/2018
Irrigation Valves (Master & Station)	Weathermatic	8200 Series, 10D, 12D, 15D, 20D, 25D, 30D	10/18/2018
Weather Sensors	Weathermatic	SLW5	10/18/2018
Flow Sensors	Weathermatic	SLFSI-T20, SLFSI-S30, SLFSI-S40	10/18/2018
Flow Communication	Weathermatic	SL-AIRCARDFLOW	10/18/2018
Wire Connectors	Spears	DS-400 Dri-Splice Pre-Filled	10/18/2018
Quick Coupling Valves	Rainbird	44-LRC (Locking Rubber Cover)	10/18/2018
Valve Manifold Boxes (Rectangular)	Carson	Spec Grade 1419, 1730	10/18/2018
Valve Box (Round)	Carson	Spec Grade 910, 2200	10/18/2018
Modular Walls	DIRRT	N/A	4/18/2019
IAS Graphical User Interface Software	DGLux5/DGLogik	IAS Graphical User Interface Software	5/16/2019
IAS Fault Detection & Diagnostic Software (FD&D)	Sky-Spark/SkyFoundry	IAS Fault Detection & Diagnostic Software (FD&D)	5/16/2019
IAS Event Automation Software	Events2HVAC/ Event Automation Software	IAS Event Automation Software	5/16/2019
Wet Barrel Fire Hydrant	Clow	2000FH Series	5/16/2019
Resilient Wedge Gate Valves	Clow	Model #s 2639 2640	5/16/2019
Ball Valve Curb Stops	Ford/McDonald	Product #s47280, 47930, 48410, 48670, 49080; B11	5/16/2019



Item	Manufacturer	Model #	Board Approval
Backflow Devices	Zurn/Wilkins	2" 975XL2/10" 375AST	5/16/2019
Fire Service Backflow Device	Zurn/Wilkins	375ASTDA	5/16/2019
Air Blow Fiber	Sumitomo	FutureFLEX Air Blown Fiber	11/21/2019
Terminal Unit Controller	Eclipse	Distech controls	1/23/2020
VAV Controller	Eclipse	Distech controls	1/23/2020
Connected System Controller	Distech Control	Distech Controls, ECY-S1000 Series	1/23/2020
Floor Boxes	Legrand	Wiremold Resource RFB Series	1/23/2020
Emergency Phones	Code Blue		4/16/2020
ISA Room Temperature Sensor	Distech Control	Allure Unitouch	4/16/2020
BLD Level Controller	Distech Control	EC BOS-8 (JACE 8000 with Drivers)	4/16/2020
Field Level Controller	Distech Control	ECY-VAV, ECY303, ECY-PTU/TU	4/16/2020
Projectors	Epson	All models	8/20/2020
Surveillance Cameras & Storage	Verkada	all models; replaces Axis	12/17/2020
Equipment, Wall devices and Accessories	Extron		9/9/2021
Samsung Monitors	Samsung		9/9/2021
Acoustic Ceiling Tile	Armstrong		2/24/2022
Window Shade Systems	Mecho Shade		2/24/2022

END OF SECTION



CHANGES TO VERSION 4.0

GENERAL

Version 4.0 continues the evolution of the MiraCosta College District Standards. This Version includes updates to formatting, organization, and other changes to aid document navigation. As with prior Versions, the Standards are not all-inclusive and continue to reference external documents and sources of information to remain current with product availability, project requirements, and changes in regulations. Content additions and modifications to **Version 3.1 Addendum 02** are identified within these standards with a cloud and “Delta” in the left margin of the page(s) for easy identification. In addition, the major changes related to modifications of District “Sole-Source” adoptions and significant content changes are summarized here.

SOLE SOURCE

A complete description of **Sole Source** items and their requirements can be found in the following section. The information here is limited to identifying the Deletions and Additions to this information from the prior Version 3.0 edition of the MiraCosta College District Standards.

Deletions:

Item	Manufacture	Model #	Board Action
DDC Thermostat	Siemens	QAA2280.FWSC	5/14/2020
HVAC Field Level Controller	Siemens (TEC)		5/14/2020
Digital Video Cameras	Axis		4/18/2019
Video Management Software	Milestone		4/18/2019

Additions:

Item	Manufacture	Model #	Board Action
Modular Walls	DIRRT	N/A	4/18/2019
IAS Graphical User Interface Software	DGLux5/DGLogik	IAS Graphical User Interface Software	5/16/2019
IAS Fault Detection & Diagnostic Software (FD&D)	Sky-Spark/SkyFoundry	IAS Fault Detection & Diagnostic Software (FD&D)	5/16/2019
IAS Event Automation Software	Events2HVAC/ Event Automation Software	IAS Event Automation Software	5/16/2019

Item	Manufacture	Model #	Board Action
Wet Barrel Fire Hydrant	Clow	2000FH Series – Pre-finished Red	5/16/2019
Resilient Wedge Gate Valves	Clow	Model #s 2639 2640	5/16/2019
Ball Valve Curb Stops	Ford/McDonald	Product #s47280, 47930, 48410, 48670, 49080; B11	5/16/2019
Backflow Devices	Zurn/Wilkins	2" 975XL2/10" 375AST	5/16/2019
Fire Service Back-flow Device	Zurn/Wilkins	375ASTDA	5/16/2019
Air Blow Fiber	Sumitomo	FutureFLEX Air Blown Fiber	11/21/2019
Terminal Unit Controller	Eclipse	Distech controls	1/23/2020
VAV Controller	Eclipse	Distech controls	1/23/2020
Connected System Controller	Distech Control	Distech Controls, ECY-S1000 Series	1/23/2020
Floor Boxes	Legrand	Wiremold Resource RFB Series	1/23/2020
Emergency Phones	Code Blue		4/16/2020
ISA Room Temperature Sensor	Distech Control	Allure Unitouch	4/16/2020
HVAC Field Level Controller	Distech Control	EC BOS-8 (JACE 8000 with Drivers)	4/16/2020
Field Level Controller	Distech Control	ECY-VAV, ECY303, ECY-PTU/TU	4/16/2020
Projectors	Epson	All models	8/20/2020
Surveillance Cameras & Storage	Verkada	all models; replaces Axis	12/17/2020
Equipment, Wall devices and Accessories	Extron		9/9/2021
Samsung Monitors	Samsung		9/9/2021
Acoustic Ceiling Tile	Armstrong		2/24/2022

Item	Manufacture	Model #	Board Action
Window Shade Systems	Mecho Shade		2/24/2022

CHANGES TO VERSION 4.0

In addition to the Sole-Source changes, the following significant changes to content are highlighted:

Specifications

All Sections: Addition of “Part 3 – Execution” to all Specification Sections that did not contain Part 3 in prior to Version 4.0.

- 05 50 00 Metal Fabrications
 - Updated Steel Finish Exceptions
- 06 10 00 Rough Carpentry
 - Changes to Dimension Lumber and Construction Panels
- 06 41 00 Architectural Wood Casework
 - Quality Assurance – Additional Requirements
 - Certified Compliance – New Section
 - Part 2 – Products – Additional Requirements
 - Cabinet Casework Locks and Keying – Additional Requirement
 - Sink Skirts – Additional Requirement
- 07 21 26 Blown Insulation – New Section
- 07 41 00 Metal Roof Panels – New Section
- 08 31 00 Access Doors and Panels
 - Performance requirements for Wall and Ceiling Mounted Access Units
- 08 42 29 Automatic Entrances – New Section
- 08 49 50 Filed Testing of Glazed Wall Systems – New Section
- 08 71 00 Door Hardware
 - Section Reformatted with current model #'s and acceptable equivalents
 - Single-Occupant Restroom Requirements
 - Requirement Prohibiting Wireless Access Control
- 08 62 23 Tubular Skylights
 - Addition of Performance Requirements
- 08 80 00 Glazing
 - Additional and Modified Performance Requirements
- 09 21 16 Gypsum Board Assemblies
 - Additional Requirements for Board Materials
- 09 22 36 Lath – New Section
- 09 24 00 Cement Plastering
 - Additional Requirements for Products
- 09 30 00 Tiling
 - Additional Requirements for Maintenance and Accessory Materials
- 09 68 16 Sheet Carpeting – New Section
- 09 84 00 Acoustical Room Components – New Section
- 09 90 00 Painting and Coating – Section Deleted
- 09 91 13 Exterior Painting – New Section
- 09 91 23 Interior Painting – New Section
- 09 96 00 High-Performance Coatings – New Section
- 10 14 00 Signage
 - Updated District Standards

- 10 26 00 Wall and Door Protection
 - Additional Product Type Information
- 10 28 00 Toilet, Bath and Laundry Accessories
 - Updated District Standards
- 11 52 13 Projection Screens
 - Section Deleted and Information relocated to Section 27 41 16 AudioVisual Systems
- 12 24 00 Window Shades – In addition to the Sole-Source requirements, changes to the following:
 - Roller Shade Fabric, Single/Double Roller Type, and Room Darkening Shades.
 - Individual Motor Controls for Double Roller Shades
 - Accessories for Fascia and Room Darkening Channels.
- 12 93 00 Site Furnishings
 - Refer to Separate Document for Relevant Standards
- 22 05 00 Common Work Results for Plumbing
 - Part 3.2 Plumbing Renovation – Additional Section
- 22 11 16 Domestic Water Piping and Fittings
 - Part 2.1 – New Section for Approved Sole Source Items
 - Wet Barrel Fire Hydrant – Additional Finish Requirement
- 22 13 19 Sanitary Waste Piping Specialties
 - Requirements for Cleanouts at Sinks and Water Closets
- 22 40 00 Plumbing Fixtures
 - Restrictions on Waterless Urinals
- 23 00 00 General
 - Requirement for HVAC Unit Labeling at Registers
- 23 74 13 Custom Air Handling Units
 - Coils – Additional Requirement for Epoxy Coating.
- 26 05 13 Medium-Voltage Cables
 - Restrictions on Splicing – Must be located on Shop Drawings, Detailed, and Specifically Approved by the District
- 26 05 33 Raceways and Boxes for Electrical Systems
 - Additional Requirements for Seal Tight Fittings
 - Additional Requirements for PVC Coated Conduit
- 26 05 43 Underground Ducts and Raceways for Electrical Systems
 - Direct-Buried Duct Banks are Not Permitted for HV and MV Systems
- 26 09 23 Lighting Control Devices
 - Additional Requirements for Networked Modules and Graphical Floor Plan
- 26 13 10 Medium Voltage Solid Dielectric Switch
 - Manufacturer Information Provided for Current Campus Infrastructure
- 26 56 00 Exterior Lighting
 - Steel Poles – Not permitted.
- 27 10 00 Communications Cabling
 - Section Revised in its Entirety
- 27 41 16 Audiovisual Systems
 - New Section
 - Replaces Section 11 52 13 Projection Screen
 - Replaces Section 27 41 00 Audiovisual Equipment – Speakers
 - Replaces Section 27 41 50 Audiovisual System Equipment & Installation
 - Replaces Section 27 51 16 Audiovisual Equipment – Mounts
- 27 51 00 Assistive Listening Systems
 - Revised Materials
- 27 51 13 Networked Paging Systems – New Section
- 28 00 00 Security Access and Surveillance – Section Deleted
- 28 13 00 Electronic Access Control System – New Section
- 28 23 00 Security Camera System
 - Section Revised in its Entirety



- Replaces Applicable Portions of Section 28 00 00 Security Access and Surveillance
- 32 11 23 Aggregate Base Courses – New Section
- 32 12 16 Asphalt Paving
 - Additional Requirements within Part 3 - Execution
- 32 84 00 Irrigation Systems
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- 32 93 16 Exterior Plants
 - All locations receiving rock mulch shall have landscape fabric.

Appendices:

Appendices have now been integrated into Version 4.0 and organized according to the Specification Division most applicable. Where Owner Project Requirements occur that may occur across Multiple Divisions, Multiple Sections, or whose location may change depending on the specific nature of the Project, those requirements have been placed in Appendix 01 - Division 01. All information contained within the Appendices shall be considered new although elements may have been carried forward from prior Versions.

Conclusion:

Other changes may be present and identified within Version 4.0 that may not be listed here. However, all projects are unique in their nature and it is the responsibility of the Project Team to review Version 4.0 for all changes.

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END OF SECTION

**SECTION 01 42 19
REFERENCE STANDARDS**

PART 1 - GENERAL

1.1 SUMMARY:

- A. The following reference standards, as a minimum, are industry wide recognized standards providing a basis for quality and reliability. Applicable construction industry standards have the same force and effect as if included in each relevant section. Such standards are made a part of these design standards by reference. Names and addresses are subject to change and are believed, but not assured, to be accurate and up-to-date as the date of this document.

1.2 REFERENCE STANDARDS:

AA	Aluminum Association Inc. http://www.aluminum.org
AABC	Associated Air Balance Council http://www.aabchq.com
AAMA	American Architectural Manufacturer's Association http://www.aamanet.org
AAN	American Nursery and Landscape Association http://www.anla.org
AASHTO	American Association of State Highway and Transportation Officials http://www.aashto.org
AATCC	American Association of Textile Chemists and Colorists http://www.aatcc.org
ACGIH	American Conference of Governmental Industrial Hygienists http://www.acgih.org
ACI	American Concrete Institute http://www.aci-int.net
ACPA	American Concrete Pipe Association http://www.concrete-pipe.org
ACPPA	American Concrete Pressure Pipe Association http://www.acppa.org



ADC	Air Diffusion Council http://flexibleduct.org
AGA	American Gas Association http://www.aga.org
AGC	Associated General Contractors of America http://www.agc.org
AGMA	American Gear Manufacturers Association, Inc. http://www.agma.org
AHAM	Association of Home Appliance Manufacturers http://www.aham.org
AIA	American Institute of Architects http://www.aia.org
AISC	American Institute of Steel Construction http://www.aisc.org
AISI	American Iron and Steel Institute http://www.steel.org
AITC	American Institute of Timber Construction http://www.aitc-glulam.org
AMCA	Air Movement and Control Association, Inc. http://www.amca.org
ANLA	American Nursery & Landscape Association http://www.anla.org
ANSI	American National Standards Institute, Inc. http://www.ansi.org
APA	The Engineered Wood Association http://www.apawood.org



ARI	Air-Conditioning and Refrigeration Institute http://www.ari.org
ASAE	American Society of Agricultural Engineers http://www.asae.org
ASCE	American Society of Civil Engineers http://www.asce.org
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers http://www.ashrae.org
ASME	American Society of Mechanical Engineers http://www.asme.org
ASSE	American Society of Sanitary Engineering http://www.asse-plumbing.org
ASTM	American Society for Testing and Materials http://www.astm.org
AWI	Architectural Woodwork Institute http://www.awinet.org
AWS	American Welding Society http://www.aws.org
AWWA	American Water Works Association http://www.awwa.org
BHMA	Builders Hardware Manufacturers Association http://www.buildershardware.com
BIA	Brick Institute of America http://www.bia.org
CAGI	Compressed Air and Gas Institute http://www.cagi.org
CGA	Compressed Gas Association, Inc. http://www.cganet.com



CI	The Chlorine Institute, Inc. http://www.chlorineinstitute.org
CISCA	Ceilings and Interior Systems Construction Association http://www.cisca.org
CISPI	Cast Iron Soil Pipe Institute http://www.cispi.org
CLFMI	Chain Link Fence Manufacturers Institute http://www.chainlinkinfo.org
CPMB	Concrete Plant Manufacturers Bureau http://www.cpmc.org
CRA	California Redwood Association http://www.calredwood.org
CRSI	Concrete Reinforcing Steel Institute http://www.crsi.org
CTI	Cooling Technology Institute http://www.cti.org
DHI	Door and Hardware Institute http://www.dhi.org
EGSA	Electrical Generating Systems Association http://www.egsa.org
EEI	Edison Electric Institute http://www.eei.org
EPA	Environmental Protection Agency http://www.epa.gov
ETL	ETL Testing Laboratories, Inc. http://www.et1.com
FAA	Federal Aviation Administration http://www.faa.gov



FCC	Federal Communications Commission http://www.fcc.gov
FPS	The Forest Products Society http://www.forestprod.org
GANA	Glass Association of North America http://www.cssinfo.com/info/gana.html/
FM	Factory Mutual Insurance http://www.fmglobal.com
GA	Gypsum Association http://www.gypsum.org
GSA	General Services Administration http://www.gsa.gov
HI	Hydraulic Institute http://www.pumps.org
HPVA	Hardwood Plywood & Veneer Association http://www.hpva.org
ICBO	International Conference of Building Officials http://www.icbo.org
ICEA	Insulated Cable Engineers Association Inc. http://www.icea.net
ICAC	Institute of Clean Air Companies http://www.icac.com
IEEE	Institute of Electrical and Electronics Engineers http://www.ieee.org
IMSA	International Municipal Signal Association http://www.imsasafety.org
IPCEA	Insulated Power Cable Engineers Association
NBMA	Metal Buildings Manufacturers Association http://www.mbma.com



MSS	Manufacturers Standardization Society of the Valve and Fittings Industry Inc. http://www.mss-hq.com
NAAMM	National Association of Architectural Metal Manufacturers http://www.naamm.org
NAPHCC	Plumbing-Heating-Cooling Contractors Association http://www.phccweb.org.org
NBS	National Bureau of Standards See - NIST
NBBPVI	National Board of Boiler and Pressure Vessel Inspectors http://www.nationboard.org
NEC	National Electric Code See - NFPA National Fire Protection Association
NEMA	National Electrical Manufacturers Association http://www.nema.org
NFPA	National Fire Protection Association http://www.nfpa.org
NHLA	National Hardwood Lumber Association http://www.natlhardwood.org
NIH	National Institute of Health http://www.nih.gov
NIST	National Institute of Standards and Technology http://www.nist.gov
NLMA	Northeastern Lumber Manufacturers Association, Inc. http://www.nelma.org
NPA	National Particleboard Association 18928 Premiere Court Gaithersburg, MD 20879 (301) 670-0604
NSF	National Sanitation Foundation http://www.nsf.org



NWWDA	Window and Door Manufacturers Association http://www.nwwda.org
OSHA	Occupational Safety and Health Administration Department of Labor http://www.osha.gov
PCA	Portland Cement Association http://www.portcement.org
PCI	Precast Prestressed Concrete Institute http://www.pci.org
PPI	The Plastic Pipe Institute http://www.plasticpipe.org
PEI	Porcelain Enamel Institute, Inc. http://www.porcelainenamel.com
PTI	Post-Tensioning Institute http://www.post-tensioning.org
RFCI	The Resilient Floor Covering Institute http://www.rfci.com
RIS	Redwood Inspection Service See - CRA
RMA	Rubber Manufacturers Association, Inc. http://www.rma.org
SCMA	Southern Cypress Manufacturers Association http://www.cypressinfo.org
SDI	Steel Door Institute http://www.steeldoor.org
SOI	Secretary of the Interior http://www.cr.nps.gov/local-law/arch_stnds_8_2.htm IGMA Insulating Glass Manufacturers Alliance http://www.igmaonline.org



SJI	Steel Joist Institute http://www.steeljoist.org
SMACNA	Sheet Metal and Air-Conditioning Contractors National Association, Inc. http://www.smacna.org
SSPC	The Society for Protective Coatings http://www.sspc.org
STI	Steel Tank Institute http://www.steeltank.com
SWI	Steel Window Institute http://www.steelwindows.com
TCA	Tile Council of America, Inc. http://www.tileusa.com
TEMA	Tubular Exchange Manufacturers Association http://www.tema.org
TPI	Truss Plate Institute, Inc. 583 D'Onofrio Drive; Suite 200 Madison, WI 53719 (608) 833-5900
UBC	The Uniform Building Code See ICBO
UL	Underwriters' Laboratories Incorporated http://www.ul.com
ULC	Underwriters' Laboratories of Canada http://www.ulc.ca
WCLIB	West Coast Lumber Inspection Bureau 6980 SW Varns Road, P.O. Box 23145 Portland, OR 97223 (503) 639-0651



WRCLA Western Red Cedar Lumber Association
P.O. Box 120786
New Brighton, MN 55112 (612) 633-
4334

WWPA Western Wood Products Association
<http://www.wwpa.org>

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 42 19



**SECTION 01 56 39
TREE AND PLANT PROTECTION**

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Preserve, protect, and prune as necessary existing trees and shrubs, and other vegetation indicated to remain.
- B. All trees and plant materials to remain on site shall be protected from all trades working on the job, and it shall be the Contractor's responsibility to insure that all subcontractors are aware of and held responsible for any damage to existing trees and plant material. In addition, Contractor shall be held responsible to insure that following protective measures are carried out throughout the entire construction period.
- C. Maintenance: Throughout the life of the construction project, the Contractor shall be responsible for overseeing the watering, fertilizing, pruning, and other measures necessary to protect all existing trees, lawns, shrubs, groundcover and other plants.
- D. Related Documents
 - 1. Construction Drawings, Technical Specifications, Addenda, and general provisions of the Contract, including Contract General Conditions and Supplementary General Conditions and other Division 01 Specification Sections, apply to this Section.
- E. Related sections
 - 1. 03 30 00 Cast-in-place Concrete
 - 2. 03 33 10 Landscape Site Concrete Walls
 - 3. 12 93 00 Site Furnishings
 - 4. 31 10 00 Site Clearing
 - 5. 31 22 00 Grading
 - 6. 31 23 16 Excavation
 - 7. 31 23 23 Fill: Compacted Subbase for Paving
 - 8. 32 12 16 Asphalt Paving
 - 9. 32 12 17 Decomposed Granite Paving
 - 10. 32 13 13 Concrete Paving
 - 11. 32 13 16 Decorative Concrete Paving
 - 12. 32 14 13 Unit Paving
 - 13. 32 84 00 Landscape Irrigation
 - 14. 32 93 13 Lawns and Grasses
 - 15. 32 93 16 Exterior Plants
 - 16. 33 41 11 Storm Utility Drainage Piping
- F. References: The following specifications and standards of the organizations and documents listed in this paragraph form a part of the specification to the extent required by the references thereto. If the requirements of the following referenced standards and specification conflict with this specification section the requirements of this specification shall prevail. If the requirements of any of the following referenced standards and specifications conflict with each other the more stringent requirement shall prevail.
 - 1. ANSI A 300 (Part 5) – Standard Practices for Tree, Shrub and other Woody Plant Maintenance, most current editions.
 - 2. Pruning practices shall conform with recommendations “Structural Pruning: A Guide for The Green Industry”; Published by Urban Tree Foundation, Visalia, California; most current edition.
 - 3. Glossary of Arboricultural Terms, International Society of Arboriculture, Champaign Il, most current edition.



1.2 VERIFICATION

- A. All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions and quantities and shall immediately inform the College's Representative of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given approval to do so by the College's Representative.

1.3 QUALITY ASSURANCE

- A. Arborist: Contractor shall engage and pay a Certified Arborist who will be responsible for supervising implementation of tree and plant protection measures specified in this Section.
 - 1. Arborist shall be subject to acceptance by College's Representative.
 - 2. Arborist registered by the American Society of Consulting Arborists.
 - 3. Submit evidence contract with acceptable Certified Arborist prior to commencing site mobilization activities.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. MULCH

- 1. Mulch shall be coarse, ground, from tree and woody brush sources. The minimum range of fine particles shall be 3/8 inch or less in size and a maximum size of individual pieces shall be approximately 1 to 1-1/2 inch in diameter and maximum length of approximately 24 to 48 inches. No more than 25% of the total volume shall be fine particles and no more than 20% of total volume be large pieces.
 - a. It is understood that mulch quality will vary significantly from supplier to supplier and region to region. The above requirements may be modified to conform to the source material from locally reliable suppliers as approved by the College's Representative.

B. BARRIERS

- 1. PLASTIC MESH FENCE: Heavy-Duty orange plastic mesh fencing fabric 48 inches wide. Fencing shall be attached to metal "U" or "T" post driven into the ground of sufficient depth to hold the fabric solidly in place without sagging. The fabric shall be attached to the post using attachment ties of sufficient number and strength to hold up the fabric without sagging. The College's Representative may request, at any time, additional post, deeper post depths and or additional fabric attachments if the fabric begins to sag, lean or otherwise not present a sufficient barrier to access.
- 2. CHAIN LINK FENCE: 6 feet tall metal chain link fence set in metal frame panels on movable post of sufficient size to hold the fence erect in areas of existing paving to remain.
- 3. GATES: For each fence type and in each separate fenced area, provide a minimum of one 3-foot-wide gate. Gates shall be lockable. The location of the gates shall be approved by the College's Representative.
- 4. Submit supplier's product data that meets the requirements for approval.

C. TREE PROTECTION SIGN

- 1. Heavy-duty cardboard or plastic signs, 8.5 inches' x 11 inches, white colored background with black 2-inch-high or larger letters in block type. The signs shall be attached to the tree protection fence every 50 feet o.c. The tree protections sign shall read, "Tree and Plant Protection Area- Keep Out".

D. FERTILIZER

- 1. Fertilizer: Unless otherwise directed by College's Representative, type and quantity of fertilizer shall be determined by soil agronomist engaged and paid by Contractor, who is acceptable to College's Representative.
 - a. As basis for bidding, fertilizer shall be Romeo "Greenbelt" 22-14-14 tree fertilizer or approved equal at 4 lb. fertilizer dissolved in 100 gallons' water.
- 2. Accessory Materials: As determined by Contractor as necessary for sustained health of trees and plants, subject to acceptance by College's Representative. Accessory materials shall include mulch, tree and plant stakes and temporary covers.



PART 3 - EXECUTION

3.1 PROTECTION

- A. Protection: Prior to construction activities, especially demolition and excavation, on the site, Contractor shall submit to College's Representative evidence of a contract with a Certified Arborist who shall be responsible for supervising implementation of the following tree protection measures.
 - 1. Protect all existing trees, shrubs and ground covers from stockpiling, material storage including soil, vehicle parking and driving within the tree drip line. Restrict foot traffic to prevent excessive compacting of soil over root systems.
 - 2. Protect root systems of existing trees, shrubs, and ground covers from damage due to chemically injurious materials in solution caused by runoff and spillage during mixing, placement of construction materials, and drainage from stored materials.
 - 3. Protect root system from flooding, erosion, excessive wetting and drying resulting from dewatering and other operations.
 - 4. Above-ground surface runoff shall not be directed into the tree canopy area from adjacent areas. Ensure that sidewalks or other construction do not trap water near the tree. Coordinate with requirements specified in Section 015700 - Temporary Controls.
 - 5. Protect existing plant materials from unnecessary cutting, breaking and skinning of roots and branches, skinning and bruising of bark.
 - 6. Use no soil sterilant under pavement near existing trees.
 - 7. Do not allow fires under and adjacent to existing trees or plants.
- B. Maintenance: Throughout duration of the Contract, Contractor shall be responsible for irrigation, fertilizing, pruning, and other measures necessary to protect and nurture all existing trees, plants, ground covers and lawns indicated to remain in Project.

3.2 PRUNING

- A. Engage approved Arborist, registered by the American Society of Consulting Arborists. Contact College's rep for contact information. Arborist shall direct removal of branches from trees and large shrubs, and correctional pruning and cabling of specified trees that are to remain, if required to clear new construction and where indicated. Arborist shall also direct necessary tree root pruning and relocation work.
- B. Where indicated by College's Representative, extend pruning operation to restore natural shape of entire tree using only Western Chapter ISA Pruning Standards.
- C. Cut branches and roots with sharp pruning instruments. Do not break, chop, or mutilate.
- D. Pruning of existing trees shall concern itself with removing all dead wood 1/2" or greater in size, removing vines and/or sucker growth. Tree cavities existing on all oak trees are to be cleaned of wood rot. The procedure for each tree may vary and will need to be approved by the Consulting Arborist prior to commencing work.
- E. Tree limbs in the way of proposed buildings shall only be trimmed by reputable ISA Certified Arborist or ISA Certified Climber and shall approved by College's Representative.

3.3 IRRIGATION

- A. Water trees and other vegetation that are to remain as necessary to maintain their health before, during and after the course of the work as directed by the Consulting Arborist. Maintain a water schedule and document. Submit schedule to College's REPRESENTATIVE.
- B. All trees shall be deep root watered by the use of an injection needle to a depth of eighteen (18) inches. Needle shall be inserted into the ground five (5) feet apart in concentric rings around the tree; each ring is four (4) feet wider than the previous one. This process shall continue out to the drip line of the tree.
- C. Trees greater than twelve (12) inches in caliper shall be watered during the first month of construction using 1,200 gallons of water per tree. For trees less than twelve (12) inches in caliper, 800 gallons of water shall be used per tree. This procedure shall be repeated every six (6) months, in addition to the normal watering schedule.

3.4 FERTILIZING

- A. All trees shall be fertilized before, during, and after construction by pumping under pressure directly 18-inches into root zone as directed by Certified Arborist.

3.5 EXCAVATION AROUND TREES

- A. Excavate within drip lines of trees only where indicated.
- B. Where trenching for utilities is required within drip lines, tunnel under and around roots of 2 1/2" diameter or larger by hand digging. Do not cut main lateral roots that are 2" or larger. Cut smaller roots that are smaller than 2" which interfere with installation of new work. Use sharp approved pruning tools. Pipes should be routed into an alternate location to avoid conflict, wherever possible.
- C. Where excavating for new construction is required within drip lines of trees, hand excavate to minimize damage to root systems. Use narrow tine spading forks and comb soil to expose roots. Relocate roots in backfill areas wherever possible. If large, main lateral roots are encountered, expose beyond excavation limits as required to bend and relocate without breaking.
- D. If encountered immediately adjacent to location of new construction and relocation is not practical, cut roots approximately six (6) inches back from new construction. Cover cut ends with plastic sandwich bag.
- E. Do not allow exposed roots to dry out before permanent backfill is placed. Provide temporary earth cover, pack with wet peat moss or four (4) layers of wet untreated burlap and temporarily support and protect from damage until permanently relocated and covered with backfill. Water to eliminate voids and air pockets.
- F. Thin branching structure in accordance with Western Chapter, ISA Pruning Standards to balance loss to root system caused by damage or cutting of root system. Thinning shall not exceed 30% of existing branching structure.

3.6 GRADING AND FILLING AROUND TREES

- A. Maintain existing grade within drip line of trees unless otherwise indicated. Any grade change shall be limited to six (6) inches of cut or fill from the original grade and shall be accomplished by hand. Under all Quercus and Pinus trees there shall be no grade change under at least the inner 50% of the tree canopy.
- B. Lowering Grades: where existing grade is above new finish grade shown around trees, carefully hand excavate within drip line to new grade. Cut roots exposed by excavation to approximately three (3) inches below elevation of new finish grade.
- C. Raising Grades: permitted only as acceptable to College's Representative.
- D. If building pads or foundations are to be constructed within the fenced areas or if the existing landscape is to be altered by the addition of fill or reduced by excavation, the College's Representative shall be notified prior to this work. Measures as approved by the College's Representative, such as small retaining walls or subgrade aeration lines, may be required to mitigate construction procedures affecting the tree.

3.7 REPAIR AND REMOVAL OF TREES

- A. Repair and Removal of Trees: Certified Arborist and College's Representative will determine whether trees shall be restored or removed. Treat and restore trees damaged by construction operations in a manner acceptable to College's Representative. Perform restoration and pruning promptly after damage occurs to prevent progressive deterioration of damaged trees. If trees cannot be restored, equitable adjustment to Contract Sum shall be made to compensate College's for loss, in accordance with the Contract General Conditions.
 - 1. Remove dead and damaged trees that are determined by Certified Arborist to be incapable of restoration to normal growth pattern.
 - 2. Contractor shall be liable for all damage and necessary restoration actions to existing trees, including trunk, branches, or roots. Restoration shall be performed under direction of Certified Arborist.



3.8 REPAIR AND REPLACEMENT OF SHRUBS AND GROUND COVER

- A. Repair shrubs and other vegetation damaged by construction operations in a manner acceptable to College's Representative. Make repairs promptly after damage occurs to prevent progressive deterioration of damaged plant.
- B. Remove and replace all dead and damaged plants that are determined by the College's Representative to be incapable of restoration to normal growth pattern.
 - 1. Provide new shrubs of same size and species as those replaced or as acceptable to the College's Representative.
 - 2. Plant and maintain as specified under Division 32.
- C. Repairs and Replacements of Shrubs and Ground Cover: Repair shrubs and other vegetation damaged by construction operation in manner acceptable to College's Representative.
 - 1. Make repairs promptly after damage occurs to prevent progressive deterioration of damaged plant. Remove and replace all dead and damaged plants up to six-inch diameter, which are determined by College's Representative as being incapable of restoration to normal growth pattern.
 - 2. Provide new shrubs of same size and species as those replaced or as acceptable to the College's Representative.

3.9 COMPENSATION TO COLLEGE'S FOR LOST AND DAMAGED TREES

- A. The Contractor shall be liable for the loss in value to damaged trees and for all repair or replacement costs resulting from construction operations as determined by the College's Representative. Because of the irreplaceable nature of many of the existing trees, the amount of assessment shall be determined by the College's Representative, depending upon tree species, condition before damage, and location value.

END OF SECTION 01 56 39

**SECTION 03 33 10
LANDSCAPE CONCRETE SITE WALLS**

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This section covers the furnishing and installing of formed and unformed cast-in-place Landscape Concrete Site Walls; including formwork, finishing, and curing in connection therewith; as shown and noted on the drawings and as specified. The conditions of the Contract and Division 1 apply to this section as fully as if repeated herein.
- B. Landscape Site Concrete Walls includes all exterior concrete structures shown on Landscape Plans except walkways.
- C. Related work in other sections:
 - 1. 01 56 39 Tree and Plant Protection
 - 2. 03 30 00 Cast in place Concrete
 - 3. 12 93 00 Site Furnishings
 - 4. 31 10 00 Site Clearing
 - 5. 31 22 00 Grading
 - 6. 31 23 Excavation
 - 7. 31 23 23 Fill: Compacted Subbase for Paving
 - 8. 32 12 16 Asphalt Paving
 - 9. 32 12 17 Decomposed Granite Paving
 - 10. 32 13 13 Concrete Paving
 - 11. 32 13 16 Decorative Concrete Paving
 - 12. 32 14 13 Unit Paving
 - 13. 32 84 00 Landscape Irrigation
 - 14. 32 84 00 Landscape Irrigation
 - 15. 32 93 13 Lawns and Grasses
 - 16. 32 93 16 Exterior Plants
 - 17. 33 41 11 Storm Utility Drainage Piping

1.2 CODES

- A. Except as modified by the requirements specified herein and/or the details on the drawings, concrete work shall conform to the "California Building Code" (CBC), Chapter 26, "Concrete".

1.3 REFERENCES

- A. The editions of the specifications and standards referenced herein, published by the following organizations, apply to the work only to the extent specified by the reference:
 - 1. American Concrete Institute (ACI). ACI 117
 - 2. American Society for Testing and Materials (ASTM). ASTM
 - 3. U.S. Department of Commerce (PS).

1.4 REFERENCE STANDARDS

- A. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials 2010 (Reapproved 2015).
- B. ASTM - ASTM Standards 2021 Standards Catalog.
- C. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete 2019.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Submit samples for approval by College's Representative for the following:
 - 1. Concrete admixture(s).



2. Aggregate(s).
3. Surface Retarder.
4. Expansion Joint and Sealant.
5. Concrete mix designs (for each type of concrete). All design mixes shall be stamped and signed by a licensed engineer.
6. Reinforcement and Forming Accessories.

1.6 SAMPLE PANELS

- A. LIGHT SAND FINISH: Sample panel: Prepare at the job site wall types indicated. Sample panel shall be supervised and directed by College's Representative. Sample panels shall be constructed until College's Representative judges that the sample panels represent the appearance and intent per the Drawings.
 1. Mix Design: The concrete mix design used to prepare the sample panels shall be identical to that used for the project's architectural concrete.
 2. The sample panels shall be indicative as the standard of color, texture and workmanship of concrete site walls to be expected in the finished work. If the College's Representative rejects any sample panel for any reason, construct additional sample panels as required to secure his approval.
 3. Remove rejected sample panels from the job site and dispose of them legally.
 4. Samples shall be prepared in a timely manner to allow review by College's Representative prior to commencement of final installation.
- B. BOARD FORM CONCRETE FINISH: Sample panel: Prepare at the job site wall types indicated. Sample panel shall be supervised and directed by College's Representative. Sample panels shall be constructed until College's Representative judges that the sample panels represent the appearance and intent per the Drawings.
 1. Mix Design: The concrete mix design used to prepare the sample panels shall be identical to that used for the project's architectural concrete.
 2. The sample panels shall be indicative as the standard of color, texture and workmanship of concrete site walls to be expected in the finished work. If the College's Representative rejects any sample panel for any reason, construct additional sample panels as required to secure his approval.
 3. Remove rejected sample panels from the job site and dispose of them legally.
 4. Samples shall be prepared in a timely manner to allow review by College's Representative prior to commencement of final installation.

1.7 QUALITY ASSURANCE

- A. Concrete designated in this section for all walls is architectural concrete and therefore the design of the mixes, design of forms, placing of concrete, production of finishes and final curing shall be so executed as to produce as near perfection as possible. Correct all concrete work, which does not conform to the requirements of the contract drawings, including strength, tolerances and finishing at no additional expense to the College's and without extension of time. Obtain College's Representative's approval of proposed corrective measures before initiating work.
- B. Provide mix designs in accordance with the applicable requirements of Section 03 3000. Properties and proportions of architectural concrete shall conform to the requirements of Section 03 3000 in addition to the requirements of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. The total estimated requirement of architectural aggregate plus anticipated losses and waste shall be procured from one source of supply. The Contractor will assure that the source of supply is adequate to provide, throughout the duration of the project, an aggregate which is uniform in size, color and shape. Should an aggregate be elected in which there is doubt about the quantity of a uniform supply, the Contractor shall require the supplier to remove the entire amount from the pit, mine or river and thoroughly mix and stockpile said aggregate for exclusive use of this project.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Forming Materials: All forms shall be new; no reused or reconditioned forms will be permitted. Forms for Concrete Site Walls shall be built so that they are completely rigid, strong enough to withstand without deflection, movement or leakage, the high hydraulic pressures which result from rapid filling and heavy frequency vibration. All materials shall be new at start of work.
- B. Form accessories as required:
1. Natural gray color concrete composed of Type II cement; sand; local rock (no black colored aggregates permitted); and water reducing, set retardant admixture.
 2. Inform retarders: Inform retarder not requiring undercoating release creating a uniform etch with retard matrix not transferred to concrete, such as Euro-tard as manufactured by Grace Products.
 3. Fasteners for formwork and installation of rustication strips, bands, reglets and reveals shall be formed galvanized steel or other approved non-corrosive steel materials.
 4. Form Ties: 1/4" snap ties, equipped with 1" diameter cone or cones which provide 1" or a 1-1/2" break-back. Whichever break-back size is selected, use throughout this work. Do not use different break-back sizes.
 5. Form ties for extra support areas: 3/8" diameter she bolts complete with 1" diameter cones.
 6. Stripping Gaskets: Resilient rectangular material non-absorbent and non-staining at junctions of formwork and at junctions for forms with columns and beams as required to permit removal and reuse of formwork without damage.
 7. Form Gaskets: 1/8" x 1/2" adhesive backed foam tape, by Burke Company, Norton Sealants, Arlon Co. or equal.
 8. Form Release Agent (compatible with sealer): Chemical non-staining release agent which will not affect the architectural concrete surface. Release agent shall be used in strict accordance with the manufacturer's recommendations. Final acceptance of form release agent depends on proven performance on sample panels. See required inform retarder prior to use of any form release agent.
 9. Form sealer shall be one of the following products:
 - a. [W.R. Grace Company](#) "Formfilm".
 - b. [Nox-Crete Chemicals, Inc.](#) "Pre-Form".
 - c. [Hunt Process Co.](#) "Seal Form-L"
 - d. Or approved equal.
 10. Chairs and Spacers: Solid plastic of color matched to architectural concrete.
 11. Reglets: "Type I Springlock Flashing Reglets" for casting into concrete, constructed from 3/16-inch thick stainless steel for exposed locations. Reglets shall be one of following products:
 - a. [Fry Reglet Co.](#)
 - b. Westex Manufacturing Ltd., Vancouver, B.C.
 - c. Or approved equal.
 12. Regular weight concrete aggregates per ASTM C-33 shall be "Imperial Valley" 3/8" rock as available through Ready-Mix Concrete, Escondido Plant, or approved equal.
 13. Water Reducing, Set Retardant Admixture: ASTM C 494-82, Type D.
 - a. ASTM C494/C494M
 14. High Range Water Reducing Admixture: ASTM C 494-82, Type F.
 - a. ASTM C494/C494M
 15. All other concrete materials: As specified in Section 32 1310, unless product is superseded by those specified herein.

2.2 STEEL REINFORCEMENT AND ACCESSORIES

- A. General: Comply with Division 03 Section "Cast-In-Place Concrete" for steel reinforcement and other requirements for reinforcement accessories.



- B. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 80 percent.
- C. Supports for Reinforcement: Lightweight, strong, non-corrosive, durable, and impervious to water. Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place, as manufactured from 100% recycled-content plastic or engineered resins from recycled ABS plastic, polycarbonates, and fiberglass.
 - 1. Products & Manufacturers: Provide products by one (1) of the following:
 - a. Rebar Supports, Eclipse Plastics Inc.
 - b. Concrete Casting Plastic Rebar Supports, Build Global, Inc.
 - c. Reinforcing Bar Supports, Shin Hwa Industrial Co.
 - d. Plastic Rebar Supports, Platicon International, Inc.
 - e. Bar Lift Plastic Support, New Century Northwest.
 - f. Aztec Composite Plastic Rebar Supports, Dayton Superior.
 - g. Or approved equal.

PART 3 - EXECUTION

3.1 MIXING

- A. Concrete shall be ready mixed concrete.

3.2 TOLERANCES OF FORMED CONCRETE SITE WALLS

- A. Formwork shall be constructed and finished so that concrete surfaces will conform to the tolerance limits listed below. Tolerances shall not be cumulative. Failure to comply with these limits will result in the Contractor, at his expense, filling and/or grinding the sub-standard surfaces, or if this is deemed impossible by the College's Representative, then the concrete section shall be removed and reconstructed at no expense to the College's.
- B. Variation from plumb for lines and surface of columns, walls, beams and arises:
 - 1. In any 10' length: 1/8".
 - 2. Maximum for entire length: 1/2".
- C. Variation from the level or from the indicated elevations of tops of slabs, beams, and arises:
 - 1. Across Top: 1/8".
 - 2. In any 10' length: 3/16".
 - 3. In any bay or in any 20' length: 1/4".
 - 4. Maximum for entire length: 1/2".
- D. Deviation from Round: Out of round, 1/4".

3.3 FORMS

- A. Design, engineering and construction of forms shall be the Contractor's responsibility.
- B. Construct forms to shape, lines and dimensions of architectural concrete members. Spacing of studs, ties and other supporting members shall be such to support maximum pressures imposed by the wet concrete (mix). Final concrete surfaces shall conform to tolerances as specified.
- C. Seal joints between form units with non-absorptive foam tape or other approved means. Use stripping gaskets at junctions of forms and forms to beams and columns to facilitate stripping and reuse of forms without damage.
- D. Forms shall be tight to prevent concrete loss. Corner chamfer strips are not allowed, making mandatory especially tight well-designed corners of the forms. Continuous girts and blocking shall be provided behind all plywood butt joints not backed.
- E. Formwork shall be cambered to compensate for construction deflections plus deadload deflections as required.
- F. Expansion and Control Joints: Locate expansion joints at 20 feet maximum on center, or where specifically indicated on the plans or as approved by the College's Representative.



- G. All forms shall be cleaned of extraneous loose material with compressed air, and thoroughly inspected before use. Forms with clips, dents, damaged corners or edges, scratches, gouges or other defects that will transfer to the concrete surface will be discarded. Forms shall be thoroughly wetted just before concrete placement. Have sufficient equipment available to allow for these procedures.

3.4 CONCRETE PLACING AND CONSOLIDATION

A. General:

1. Place no concrete before forms are complete, reinforcement secured in place, all built-in items in place, form ties at construction joints tightened, and the work observed by College's Representative.
2. Keep a record of time and date of placing of concrete in each portion of the project.
3. Carry on concrete work as a continuous operation until selection of approved size and shape is completed. Cut-offs and construction joints shall be of approved detail and location.
4. Provide the College's Representative with 24-hour notice when the concrete is to be placed.
5. Provide such equipment and employ only those methods and arrangements of equipment, which will reduce a minimum separation of coarse aggregate from the concrete. Select the equipment for its ability to handle concrete of the lowest slump that can be consolidated by means of vibration after placement.

B. Placing:

1. Concrete shall be deposited as nearly as practicable directly in its final position and shall not be caused to flow such that the lateral movement will cause segregation of the course aggregate mortar or water from the concrete mass.
2. Retempering of mix, which has partially set, is prohibited. Place all concrete in forms not more than 1-1/2 hours after water is added to the mixture. Place no concrete when sun, wind, heat or limitations of provided facilities will prevent proper finishing and curing.
3. Take special care to completely fill forms by depositing as near final position as possible, and to force concrete under and around reinforcement without displacement. After deposited concrete has taken initial set, exercise care to avoid jarring forms or placing strain on ends of projecting reinforcement.

C. Consolidation:

1. Place vibrators in the concrete rapidly to minimize entrapped air between concrete and forms, and thoroughly blend the layers. Remove vibrator slowly from concrete to break up and release air entrapped between concrete and forms. Minimum spacing of vibrator in sections shall be in accordance with manufacturer's recommended radius of influence.
2. Provide a minimum of 1 spare vibrator at each location where concrete is being placed during architectural concrete placing. Vibrators shall be 180-cycle, 2-1/2" diameter, minimum frequency 9,000 impulses per minute with amplitude no less than 0.040", to a maximum of 12,000 impulses per minute with an amplitude not less than 0.075".
3. Vibrator heads shall not come within 2-1/2" of face of architectural concrete.
4. In the event during placing operation there is a delay of more than 15 minutes, manipulate previous left with vibrators just prior to placement of fresh concrete.

3.5 REINFORCEMENT AND INSERTS

- A. General: Comply with Division 03 Section "Cast-In-Place Concrete" for fabricating and installing steel reinforcement. Securely fasten steel reinforcement and wire ties against shifting during concrete placement.
- B. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.6 FORM REMOVAL

- A. Design forms to permit their removal without damaging architectural concrete. Do not pry against exposed concrete surfaces when removing the forms.
- B. Do not remove forms until concrete has attained sufficient strength to permit form removal with safety.



3.7 PROTECTING AND CURING

- A. Protecting:
 - 1. Protect concrete site walls from any damage by the elements and defacement of any nature during construction operations.
 - 2. All corners and surfaces subject to possible damage shall be suitably protected.
 - 3. Keep all exposed concrete free from laitance caused by spillage, leaking forms or other contaminants. In no event shall laitance be allowed to penetrate, stain or harden on surfaces, which have been sandblasted.
- B. Curing
 - 1. Use no curing method which could impair the appearance of concrete site wall surfaces.
 - 2. Curing material used will restrict the loss of moisture to not more than 0.055 grams per square centimeter of surface.
 - 3. All concrete shall be cured for a period of not less than 10 days. During this curing period no part of the concrete shall be permitted to become dry even for a short while. The curing medium shall be applied so as to prevent checking and cracking of the surface of the concrete immediately after placing and it shall be maintained so as to prevent loss of water from the concrete for the duration of the entire curing period. Fresh concrete shall be protected from heavy rains, flowing water, and mechanical injury. All concrete shall be protected from injurious action of the sun.
 - 4. Methods of Curing: If cured with water, concrete shall be kept wet by mechanical sprinklers or by any other approved method, which will keep the surfaces continuously wet with "fresh" water.

3.8 FINISHING

- A. Apply a finish on architectural concrete surfaces as indicated on drawings or notes. Walls may be a different texture than curbs, based upon samples provided by Contractor. Otherwise, texture of concrete surfaces shall be as selected by the College's Representative from samples prepared in a range as follows:
 - 1. Light Sand finish: Expose fine aggregate with no exposure of coarse aggregate - 1/16" reveal.
 - 2. Board Form Concrete Finish: 2x6 board horizontal layout.

3.9 DEFECTIVE CONCRETE

- A. As specified in Section 03 30 10, with the added provision that architectural concrete that is discolored, stained or mottled, and cannot be satisfactorily repaired to the College's Representative's satisfaction, will be considered defective, and shall be replaced with satisfactory architectural concrete at no additional cost to the College.

END OF SECTION 03 33 10

SECTION 03 35 11
CONCRETE FLOOR FINISHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Surface treatments for concrete floors and slabs.
- B. Liquid densifiers and hardeners.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with concrete floor placement and concrete floor curing.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's published data on each finishing product, including information on compatibility of different products and limitations.
- C. Maintenance Data: Provide data on maintenance and renewal of applied finishes.

1.4 MOCK-UP

- A. For coatings, construct mock-up area under conditions similar to those that will exist during application, with coatings applied.
- B. Locate where directed.
- C. Mock-up may remain as part of the work.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's sealed packaging, including application instructions.

1.6 FIELD CONDITIONS

- A. Maintain light level equivalent to a minimum 200 W light source at 8 feet (2.5 m) above the floor surface over each 20 foot (6 m) square area of floor being finished.

PART 2 - PRODUCTS

2.1 DENSIFIERS AND HARDENERS

- A. Liquid Densifier and Hardener: Penetrating chemical compound that reacts with concrete, filling the pores and dustproofing; for application to concrete after set.
 - 1. Composition: Sodium silicate.
 - 2. Products:
 - a. Kaufman Products Inc; [SureHard](http://www.kaufmanproducts.net): www.kaufmanproducts.net.
 - b. L&M Construction Chemicals, Inc, a subsidiary of Laticrete International, Inc; [SEAL HARD](http://www.lmcc.com): www.lmcc.com.
 - c. SpecChem, LLC; [Cure Hard](http://www.specchemllc.com): www.specchemllc.com.
 - d. SpecChem, LLC; [SpecHard](http://www.specchemllc.com): www.specchemllc.com.
 - e. W. R. Meadows, Inc; [Liqui-Hard](http://www.wrmeadows.com): www.wrmeadows.com.
 - f. Or approved equal.
 - g. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that floor surfaces are acceptable to receive the work of this section.
- B. Verify that flaws in concrete have been patched and joints filled with methods and materials suitable for further finishes.



3.2 GENERAL

- A. Apply materials in accordance with manufacturer's instructions.

3.3 COATING APPLICATION

- A. Verify that surface is free of previous coatings, sealers, curing compounds, water repellents, laitance, efflorescence, fats, oils, grease, wax, soluble salts, residues from cleaning agents, and other impediments to adhesion.
- B. Protect adjacent non-coated areas from drips, overflow, and overspray; immediately remove excess material.
- C. Apply coatings in accordance with manufacturer's instructions, matching approved mock-ups for color, special effects, sealing and workmanship.

END OF SECTION 03 35 11

**SECTION 04 20 00
UNIT MASONRY**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Concrete block.
- B. Mortar and grout.
- C. Reinforcement and anchorage.
- D. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry: Nailing strips built into masonry.

1.3 REFERENCE STANDARDS

- A. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire 2019.
- B. ASTM A951/A951M - Standard Specification for Steel Wire for Masonry Joint Reinforcement 2016, with Editorial Revision (2018).
- C. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2018a.
- D. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units 2016a.
- E. ASTM C91/C91M - Standard Specification for Masonry Cement 2018.
- F. ASTM C140/C140M - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units 2021.
- G. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar 2018.
- H. ASTM C150/C150M - Standard Specification for Portland Cement 2021.
- I. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes 2018.
- J. ASTM C270 - Standard Specification for Mortar for Unit Masonry 2019.
- K. ASTM C404 - Standard Specification for Aggregates for Masonry Grout 2018.
- L. ASTM C476 - Standard Specification for Grout for Masonry 2020.
- M. ASTM C1072 - Standard Test Methods for Measurement of Masonry Flexural Bond Strength 2019.
- N. ASTM C1148 - Standard Test Method for Measuring the Drying Shrinkage of Masonry Mortar 1992a (Reapproved 2014).
- O. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms 2021.
- P. ASTM D226/D226M - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing 2017.
- Q. ASTM E514/E514M - Standard Test Method for Water Penetration and Leakage Through Masonry 2014a.
- R. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures 2016.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by all relevant installers.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.

- C. Samples: Submit two samples of concrete masonry units to illustrate color, texture, and extremes of color range.
- D. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.
- E. Manufacturer's Certificate: Certify that water repellent admixture manufacturer has certified masonry unit manufacturer as an approved user of water repellent admixture in the manufacture of concrete block.
- F. Test Reports: Concrete masonry manufacturer's test reports for units with integral water repellent admixture.

1.6 QUALITY ASSURANCE

- A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.
 - 1. Maintain one copy of each document on project site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with minimum three years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

- A. Concrete Block: Comply with referenced standards and as follows:
 - 1. Size: Standard units with nominal face dimensions of 16 by 8 inches (400 by 200 mm) and nominal depths as indicated on drawings for specific locations.
 - 2. Load-Bearing Units: ASTM C90, normal weight.
 - a. Solid block, as indicated.
 - b. Exposed Faces: Manufacturer's standard color and texture where indicated.
 - 3. Units with Integral Water Repellent: Concrete block units as specified in this section with polymeric liquid admixture added to concrete masonry units at the time of manufacture.
 - a. Performance of Units with Integral Water Repellent:
 - 1) Water Permeance: When tested per ASTM E514/E514M and for a minimum of 72 hours.
 - a) No water visible on back of wall above flashing at the end of 24 hours.
 - b) No flow of water from flashing equal to or greater than 0.032 gallons per hour (0.05 L per hour) at the end of 24 hours.
 - c) No more than 25 percent of wall area above flashing visibly damp at end of test.
 - 2) Flexural Bond Strength: ASTM C1072; minimum 10 percent increase.
 - 3) Compressive Strength: ASTM C1314; maximum 5 percent decrease.
 - 4) Drying Shrinkage: ASTM C1148; maximum 5 percent increase in shrinkage.
 - b. Use only in combination with mortar that also has integral water repellent admixture.
 - c. Use water repellent admixtures for masonry units and mortar by a single manufacturer.

2.2 MORTAR AND GROUT MATERIALS

- A. Grout: Shall comply with Article 2.2 TMS 602/ACI 530.1/ASCE 6 with a minimum strength of 2,000psi.
- B. Mortar: ASTM C91/C91M, Type S with minimum strength of 1,800 psi or Type M with minimum strength of 2,500 psi.
- C. Masonry Cement: ASTM C91/C91M, Type N.
- D. Portland Cement: ASTM C150/C150M, Type I; color as required to produce approved color sample.
 - 1. Not more than 0.60 percent alkali.
- E. Hydrated Lime: ASTM C207, Type S.

- F. Mortar Aggregate: ASTM C144.
- G. Grout Aggregate: ASTM C404.
- H. Water: Clean and potable.

2.3 REINFORCEMENT AND ANCHORAGE

- A. Single Wythe Joint Reinforcement: ASTM A951/A951M.
 - 1. Type: Truss or ladder.
 - 2. Material: ASTM A1064/A1064M steel wire, mill galvanized to ASTM A641/A641M Class 3.
 - 3. Size: 0.1483 inch (3.8 mm) side rods with 0.1483 inch (3.8 mm) cross rods; width as required to provide not less than 5/8 inch (16 mm) of mortar coverage on each exposure.
- B. Flexible Anchors: 2-piece anchors that permit differential movement between masonry and building frame, sized to provide not less than 5/8 inch (16 mm) of mortar coverage from masonry face.

2.4 ACCESSORIES

- A. Building Paper: ASTM D226/D226M, Type I ("No.15") asphalt felt.
- B. Nailing Strips: Softwood lumber, preservative treated; as specified in Section 06 10 00.
- C. Drainage Fabric: Polyester or polypropylene mesh bonded to a water and vapor-permeable fabric.
 - 1. Manufacturers:
 - a. Advanced Building Products, Inc; Mortairvent: www.advancedbuildingproducts.com.
 - b. Mortar Net Solutions; DriPlane: www.mortarnet.com.
 - c. York Manufacturing, Inc; Weep Armor Weep Vent Protection: www.yorkmfg.com.
 - d. Or approved equal.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.5 MORTAR AND GROUT MIXING

- A. Mortar for Unit Masonry: ASTM C270, using the Proportion Specification.
 - 1. Masonry below grade and in contact with earth: Type S or M.
 - 2. Exterior, loadbearing masonry: Type S or M.
- B. Grout: ASTM C476; consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches (50 mm) or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches (50 mm).
- C. Admixtures: Add to mixture at manufacturer's recommended rate and in accordance with manufacturer's instructions; mix uniformly.
- D. Mixing: Use mechanical batch mixer and comply with referenced standards.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Not Applicable.

3.2 PREPARATION

- A. Not Applicable.

3.3 COLD AND HOT WEATHER REQUIREMENTS

- A. Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.

3.4 COURSING

- A. Establish lines, levels, and coursing indicated. Protect from displacement.
- B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- C. Concrete Masonry Units:

3.5 PLACING AND BONDING

- A. Lay hollow masonry units with face shell bedding on head and bed joints.
- B. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- C. Remove excess mortar and mortar smears as work progresses.
- D. Remove excess mortar with water repellent admixture promptly. Do not use acids, sandblasting or high pressure cleaning methods.
- E. Interlock intersections and external corners, except for units laid in stack bond.
- F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
- H. Cut mortar joints flush where wall tile is scheduled or resilient base is scheduled.

3.6 REINFORCEMENT AND ANCHORAGE - GENERAL, SINGLE WYTHE MASONRY, AND CAVITY WALL MASONRY

- A. Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches (400 mm) on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches (400 mm) each side of opening.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Embed longitudinal wires of joint reinforcement in mortar joint with at least 5/8 inch (16 mm) mortar cover on each side.
- E. Lap joint reinforcement ends minimum 6 inches (150 mm).
- F. Reinforce stack bonded unit joint corners and intersections with strap anchors 16 inches (400 mm) on center.
- G. Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 36 inches (900 mm) horizontally and 24 inches (600 mm) vertically.

3.7 GROUTED COMPONENTS

- A. Not Applicable.

3.8 TOLERANCES

- A. Install masonry within the site tolerances found in TMS 402/602.

3.9 PARGING

- A. Dampen masonry walls prior to parging.
- B. Scarify each parging coat to ensure full bond to subsequent coat.

3.10 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 4000 - Quality Requirements.
- B. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140/C140M for compliance with requirements of this specification.

3.11 CLEANING

- A. Remove excess mortar and mortar droppings.
- B. Replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces with cleaning solution.



3.12 PROTECTION

- A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION 04 20 00

**SECTION 05 50 00
METAL FABRICATIONS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Shop fabricated steel items.

1.2 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2020.
- C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- D. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates 2018.
- E. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing 2014.
- F. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength 2019, with Editorial Revision (2020).
- G. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination 2012.
- H. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification 2014 (Amended 2015).
- I. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020.
- J. AWS D1.2/D1.2M - Structural Welding Code - Aluminum 2014, with Errata.
- K. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel 2018.
- L. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer 1999 (Ed. 2004).
- M. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic") 2002 (Ed. 2004).
- N. SSPC-SP 2 - Hand Tool Cleaning 2018.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- C. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
- D. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is accredited under IAS AC172.

1.4 QUALITY ASSURANCE

- A. Design structural items under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.
- B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.2/D1.2M and dated no more than 12 months before start of scheduled welding work.

- C. Fabricator Qualifications: A qualified steel fabricator that is accredited by IAS AC172.

PART 2 - PRODUCTS

2.1 MATERIALS - STEEL

- A. Steel Sections: ASTM A36/A36M.
- B. Steel Tubing: ASTM A501/A501M hot-formed structural tubing.
- C. Plates: ASTM A283/A283M.
- D. Pipe: ASTM A53/A53M, Grade B Schedule 40, black finish.
- E. Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, plain.
- F. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- G. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- H. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.2 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- D. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.3 FABRICATED ITEMS

- A. Bumper Posts and Guard Rails: As detailed; prime paint finish.
- B. Bollards: Steel pipe, concrete filled, crowned cap, as detailed; prime paint finish.
- C. Ledge Angles, Shelf Angles, Channels, and Plates Not Attached to Structural Framing: For support of metal decking; prime paint finish.
- D. Lintels: As detailed; prime paint finish.

2.4 FINISHES - STEEL

- A. Prime paint steel items
 - 1. Exceptions: Galvanize items to be embedded in concrete and items to be embedded in masonry.
 - 2. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.
- B. Prepare surfaces to be primed in accordance with SSPC-SP2.
- C. Prime Painting: One coat.
- D. Galvanizing of Non-structural Items: Galvanize after fabrication to ASTM A123/A123M requirements.

2.5 FABRICATION TOLERANCES

- A. Squareness: 1/8 inch (3 mm) maximum difference in diagonal measurements.
- B. Maximum Offset Between Faces: 1/16 inch (1.5 mm).
- C. Maximum Misalignment of Adjacent Members: 1/16 inch (1.5 mm).
- D. Maximum Bow: 1/8 inch (3 mm) in 48 inches (1.2 m).
- E. Maximum Deviation From Plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.2 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.3 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Field weld components as indicated on drawings.
- D. Perform field welding in accordance with AWS D1.1/D1.1M.
- E. Obtain approval prior to site cutting or making adjustments not scheduled.
- F. After erection, prime welds, abrasions, and surfaces not shop primed , except surfaces to be in contact with concrete.

3.4 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch (6 mm) per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch (6 mm).
- C. Maximum Out-of-Position: 1/4 inch (6 mm).

END OF SECTION 05 50 00

**SECTION 05 52 13
PIPE AND TUBE RAILINGS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Wall mounted handrails.
- B. Stair railings and guardrails.
- C. Free-standing railings at steps.
- D. Balcony railings and guardrails.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Placement of anchors in concrete.
- B. Section 04 20 00 - Unit Masonry: Placement of anchors in masonry.
- C. Section 09 21 16 - Gypsum Board Assemblies: Placement of backing plates in stud wall construction.

1.3 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2020.
- C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- D. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes 2021a.
- E. ASTM E935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings 2021.
- F. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic") 2002 (Ed. 2004).

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.
- C. Designer's Qualification Statement.
- D. Fabricator's Qualification Statement.

1.5 CODE REQUIREMENTS

- A. Railings and handrails: CBC Section 11B-505
 - 1. Top of gripping surfaces of handrails shall be 34" minimum and 38" maximum vertically above walking surfaces, stair nosings, and ramp surfaces. Handrails shall be at a consistent height above such surfaces.
 - 2. Clearance between handrail gripping surfaces and adjacent surfaces shall be 1 ½" minimum. Handrail may be located in a recess if the recess is 3" maximum deep and 18" minimum clear above the top of the handrail.
 - 3. Handrail gripping surfaces shall be continuous along their length and shall not be obstructed along their tops or sides. The bottoms of handrail gripping surfaces shall not be obstructed for more than 20% of their length. Where provided, horizontal projections shall occur 1 ½" minimum below the bottom of the handrail gripping surfaces.
 - 4. Handrail gripping surfaces with a circular cross section shall have an outside diameter of 1 ¼" minimum and 2" maximum.
 - 5. Handrail gripping surfaces with a non-circular cross section shall have an outside dimension of 4" minimum and 6 ¼" maximum, and a cross-sectional dimension of 2 ¼" maximum.

6. Handrail gripping surfaces and any surfaces adjacent to them shall be free of sharp or abrasive elements and shall have rounded edges.
7. Handrails shall not rotate within their fittings.
8. Handrail gripping surfaces shall extend beyond and in the same direction of stair flights and ramp runs in accordance with CBC Section 11B-505.10. Such extensions are not required for continuous handrails at the inside turn of switchback or dogleg stairs and ramps.
9. A 2" minimum high curb or a barrier shall be provided to prevent the passage of a 4" diameter sphere rolling off the sides of a ramp surface. Such a curb or a barrier shall be continuous and uninterrupted along the length of a ramp. CBC Section 11B-405.9.2

PART 2 - PRODUCTS

2.1 RAILINGS - GENERAL REQUIREMENTS

- A. Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of applicable local code.
- B. Distributed Loads: Design railing assembly, wall rails, and attachments to resist distributed force of 75 pounds per linear foot (1095 N/m) applied to the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935.
- C. Concentrated Loads: Design railing assembly, wall rails, and attachments to resist a concentrated force of 200 pounds (890 N) applied at any point on the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935.
- D. Allow for expansion and contraction of members and building movement without damage to connections or members.
- E. Dimensions: See drawings for configurations and heights.
- F. Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.
 1. For anchorage to concrete, provide inserts to be cast into concrete, for bolting anchors.
 2. For anchorage to masonry, provide brackets to be embedded in masonry, for bolting anchors.
 3. For anchorage to stud walls, provide backing plates, for bolting anchors.
- G. Provide welding fittings to join lengths, seal open ends, and conceal exposed mounting bolts and nuts, including but not limited to elbows, T-shapes, splice connectors, flanges, escutcheons, and wall brackets.

2.2 STEEL RAILING SYSTEM

- A. Steel Tube: ASTM A500/A500M Grade B cold-formed structural tubing.
- B. Steel Pipe: ASTM A53/A53M Grade B Schedule 80, black finish.
- C. Non-Weld Mechanical Fittings: Slip-on, galvanized malleable iron castings, for Schedule 40 pipe, with flush setscrews for tightening by standard hex wrench, no bolts or screw fasteners.
- D. Welding Fittings: Factory- or shop-welded from matching pipe or tube; seams continuously welded; joints and seams ground smooth.
- E. Exposed Fasteners: No exposed bolts or screws.
- F. Galvanizing: In accordance with requirements of ASTM A123/A123M.
 1. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20 Type I - Inorganic.

2.3 FABRICATION

- A. Accurately form components to suit specific project conditions and for proper connection to building structure.
- B. Fit and shop assemble components in largest practical sizes for delivery to site.
- C. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.



- D. Welded Joints:
1. Exterior Components: Continuously seal joined pieces by intermittent welds and plastic filler. Drill condensate drainage holes at bottom of members at locations that will not encourage water intrusion.
 2. Interior Components: Continuously seal joined pieces by intermittent welds and plastic filler.
 3. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.2 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply items required to be cast into concrete or embedded in masonry with setting templates, for installation as work of other sections.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.
- C. Install railings in compliance with ADA Standards for accessible design at applicable locations.
- D. Anchor railings securely to structure.
- E. Field weld anchors as indicated on drawings. Touch-up welds with primer. Grind welds smooth.
- F. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

3.4 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch (6 mm) per floor level, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch (6 mm).
- C. Maximum Out-of-Position: 1/4 inch (6 mm).

END OF SECTION 05 52 13

**SECTION 06 10 00
ROUGH CARPENTRY**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Structural dimension lumber framing.
- B. Nonstructural dimension lumber framing.
- C. Rough opening framing for doors, windows, and roof openings.
- D. Sheathing.
- E. Underlayment.
- F. Roofing nailers.
- G. Roofing cant strips.
- H. Preservative treated wood materials.
- I. Miscellaneous framing and sheathing.
- J. Communications and electrical room mounting boards.
- K. Concealed wood blocking, nailers, and supports.
- L. Miscellaneous wood nailers, furring, and grounds.

1.2 RELATED REQUIREMENTS

- A. Section 07 62 00 - Sheet Metal Flashing and Trim: Sill flashings.

1.3 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- B. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials 2016.
- C. AWC (WFCM) - Wood Frame Construction Manual for One- and Two-Family Dwellings 2018.
- D. AWPA U1 - Use Category System: User Specification for Treated Wood 2018.
- E. ICC-ES AC308 - Acceptance Criteria for Termite Physical Barrier Systems 2014, with Editorial Revision (2017).
- F. PS 2 - Performance Standard for Wood-Based Structural-Use Panels 2010.
- G. PS 20 - American Softwood Lumber Standard 2020.
- H. WCLIB (GR) - Standard Grading Rules for West Coast Lumber No. 17 2018.
- I. WWPA G-5 - Western Lumber Grading Rules 2017.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide technical data on insulated sheathing, wood preservative materials, and application instructions.
- C. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.
- D. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.



1.6 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Correct defective work within a five-year period commencing on Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. Species: Douglas Fir-Larch, unless otherwise indicated.
 - 2. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.
 - 3. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
- B. Lumber salvaged from deconstruction or demolition of existing buildings or structures is permitted provided it is clean, denailed, and free of paint and finish materials, and other contamination; identify source.

2.2 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Grading Agency: West Coast Lumber Inspection Bureau; WCLIB (GR).
- B. Grading Agency: Western Wood Products Association; WWPA G-5.
- C. Sizes: Nominal sizes as indicated on drawings, S4S.
- D. Moisture Content: S-dry or MC19.
- E. Stud Framing (2 by 2 through 2 by 6 (50 by 50 mm through 50 by 150 mm)):
 - 1. Species: Douglas Fir-Larch.
 - 2. Grade: No. 2.
- F. Joist, Rafter, and Small Beam Framing (2 by 6 through 4 by 16 (50 by 150 mm through 100 by 400 mm)).
 - 1. Species: Douglas Fir-Larch.
 - 2. Grade: No. 1 and Better.
- G. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 - 1. Lumber: S4S, No. 2 or Standard Grade.
 - 2. Boards: Standard or No. 3.

2.3 TIMBERS FOR CONCEALED APPLICATIONS

- A. Grading Agency: West Coast Lumber Inspection Bureau; WCLIB (GR).
- B. Grading Agency: Western Wood Products Association; WWPA G-5.
- C. Sizes: Nominal sizes as indicated on drawings, S4S.
- D. Moisture Content: S-dry (19 percent maximum).
- E. Beams and Posts 5 inches (125 mm) and over in thickness:
 - 1. Species: Douglas Fir-Larch.
 - 2. Grade: Select Structural.

2.4 CONSTRUCTION PANELS

- A. Roof Sheathing: PS 2 type, rated Structural I Sheathing.
 - 1. Bond Classification: Exposure 1.
 - 2. Span Rating: 24.
 - 3. Performance Category: 3/4 PERF CAT.
- B. Wall Sheathing: PS 2 type.
 - 1. Bond Classification: Exposure 1.

2. Grade: Structural I Sheathing.
3. Span Rating: 16.

4. Performance Category: 5/16 PERF CAT
5. Edge Profile: Square edge.

2.5 ACCESSORIES

- A. Fasteners and Anchors:
 1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
 2. Drywall Screws: Bugle head, hardened steel, power driven type, length three times thickness of sheathing.
- B. Die-Stamped Connectors: Hot dipped galvanized steel, sized to suit framing conditions.
- C. Joist Hangers: Hot dipped galvanized steel, sized to suit framing conditions.
- D. Sill Gasket on Top of Foundation Wall: 1/4 inch (6 mm) thick, plate width, closed cell plastic foam from continuous rolls.
- E. Termite-Resistant Sill Plate Barrier: Self-adhesive, film-backed barrier with release sheet; adheres to concrete substrates and blocks termite access.
 1. Thickness: 68 mil, 0.068 inch (1.7 mm).
 2. Termite Resistance: 100 percent when tested in accordance with ICC-ES AC380.
 3. Water Vapor Permeance: 0.035 perm (2 ng/(Pa s sq m)), maximum, when tested in accordance with ASTM E96/E96M.
- F. Sill Flashing: See Section 07 6200.

2.6 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 1. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.
- B. Preservative Treatment:
 1. Manufacturers:
 - a. Lonza Group: www.wolmanizedwood.com.
 - b. Koppers Performance Chemicals, Inc: www.koppersperformancechemicals.com.
 - c. Viance, LLC: www.treatedwood.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Preservative Pressure Treatment of Lumber Above Grade: AWPA U1, Use Category UC3B, Commodity Specification A using waterborne preservative.
 - a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - b. Treat lumber in contact with roofing, flashing, or waterproofing.
 - c. Treat lumber in contact with masonry or concrete.
 - d. Treat lumber less than 18 inches (450 mm) above grade.
 - e. Treat lumber in other locations as indicated.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Where wood framing bears on cementitious foundations, install full width sill flashing continuous over top of foundation, lap ends of flashing minimum of 4 inches (100 mm) and seal.
- B. Install sill gasket under sill plate of framed walls bearing on foundations; puncture gasket cleanly to fit tightly around protruding anchor bolts.

3.2 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.3 FRAMING INSTALLATION

- A. Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members.
- B. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.
- C. Install structural members full length without splices unless otherwise specifically detailed.
- D. Comply with member sizes, spacing, and configurations indicated, and fastener size and spacing indicated, but not less than required by applicable codes, AWC (WFCM) Wood Frame Construction Manual.
- E. Construct double joist headers at floor and ceiling openings and under wall stud partitions that are parallel to floor joists; use metal joist hangers unless otherwise detailed.
- F. Frame wall openings with two or more studs at each jamb; support headers on cripple studs.

3.4 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- B. In framed assemblies that have concealed spaces, provide solid wood fire blocking as required by applicable local code, to close concealed draft openings between floors and between top story and roof/attic space; other material acceptable to authorities having jurisdiction may be used in lieu of solid wood blocking.
- C. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
- D. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
- E. Provide the following specific nonstructural framing and blocking:
 - 1. Cabinets and shelf supports.
 - 2. Wall brackets.
 - 3. Handrails.
 - 4. Grab bars.
 - 5. Towel and bath accessories.
 - 6. Wall-mounted door stops.
 - 7. Chalkboards and marker boards.
 - 8. Wall paneling and trim.
 - 9. Joints of rigid wall coverings that occur between studs.

3.5 INSTALLATION OF CONSTRUCTION PANELS

- A. Roof Sheathing: Secure panels with long dimension perpendicular to framing members, with ends staggered and over firm bearing.
 - 1. Nail panels to framing; staples are not permitted.
- B. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using nails, screws, or staples.



- C. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches (610 mm) on center on all edges and into studs in field of board.
 - 1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
 - 2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
 - 3. Install adjacent boards without gaps.
 - 4. Size and Location: As indicated on drawings.

3.6 TOLERANCES

- A. Framing Members: 1/4 inch (6 mm) from true position, maximum.
- B. Variation from Plane, Other than Floors: 1/4 inch in 10 feet (2 mm/m) maximum, and 1/4 inch in 30 feet (7 mm in 10 m) maximum.

3.7 CLEANING

- A. Waste Disposal: See Section 01 74 19 - Construction Waste Management and Disposal.
 - 1. Comply with applicable regulations.
 - 2. Do not burn scrap on project site.
 - 3. Do not burn scraps that have been pressure treated.
 - 4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.
- B. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.
- C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION 06 10 00

**SECTION 06 20 00
FINISH CARPENTRY**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Finish carpentry items at building exterior and interior.

1.2 RELATED REQUIREMENTS

- A. Section 09 91 13 - Exterior Painting: Painting of finish carpentry items.
- B. Section 09 91 23 - Interior Painting: Painting of finish carpentry items.

1.3 REFERENCE STANDARDS

- A. AWI/AWMAc/WI (AWS) - Architectural Woodwork Standards, 2nd Edition 2014, with Errata (2016).
- B. AWMAc/WI (NAAWS) - North American Architectural Woodwork Standards, U.S. Version 4.0 2021, with Errata.
- C. PS 1 - Structural Plywood 2009 (Revised 2019).

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide manufacturer's product data, storage and handling instructions for factory-fabricated units.
- C. Samples: Submit two samples of wood trim 8 inch (203.2 mm) long.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect from moisture damage.

PART 2 - PRODUCTS

2.1 FINISH CARPENTRY ITEMS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAc/WI (AWS) or AWMAc/WI (NAAWS), unless noted otherwise.
- B. Exterior Woodwork Items:
 - 1. Soffits and Fascias: Prepare for paint finish.
- C. Interior Woodwork Items:
 - 1. Moldings, Bases, Casings, and Miscellaneous Trim: Clear white pine; prepare for paint finish.

2.2 WOOD-BASED COMPONENTS

- A. Provide sustainably harvested wood, certified or labeled as specified in Section 01 60 00 - Product Requirements.

2.3 LUMBER MATERIALS

- A. Softwood Lumber: Cedar species, smooth sawn, maximum moisture content of 6 percent; with vertical grain, of quality suitable for transparent finish.
 - 1. Grading: In accordance with rules certified by ALSC; www.alsc.org.

2.4 SHEET MATERIALS

- A. Softwood Plywood, Exposed to View: Face species as indicated, plain sawn, medium density fiberboard core; PS 1 Grade A-B, glue type as recommended for application.
 - 1. Grading: Certified by the American Plywood Association.

2.5 FASTENINGS

- A. Fasteners for Exterior Applications: Hot-dipped galvanized steel complying with ASTM A153/A153M; length required to penetrate wood substrate 1-1/2 inch (38 mm) minimum.

2.6 ACCESSORIES

- A. Lumber for Shimming and Blocking: Softwood lumber of indicated species.
- B. Primer: Alkyd primer sealer.
- C. Wood Filler: Solvent base, tinted to match surface finish color.

2.7 FABRICATION

- A. Shop assemble work for delivery to site, permitting passage through building openings.
- B. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify adequacy of backing and support framing.

3.2 INSTALLATION

- A. Install custom fabrications in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.
- B. Set and secure materials and components in place, plumb and level.
- C. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch (0.79 mm). Do not use additional overlay trim to conceal larger gaps.

3.3 SITE APPLIED WOOD TREATMENT

- A. Apply preservative treatment in accordance with manufacturer's instructions.
- B. Brush apply one coats of preservative treatment on wood in contact with cementitious materials. Treat site-sawn cuts.
- C. Allow preservative to dry prior to erecting members.

3.4 PREPARATION FOR SITE FINISHING

- A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.
- B. Site Finishing: See Section 09 91 13 and 09 91 23.
- C. Before installation, prime paint surfaces of items or assemblies to be in contact with cementitious materials.

3.5 TOLERANCES

- A. Maximum Variation from True Position: 1/16 inch (1.6 mm).
- B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch (0.79 mm).

END OF SECTION 06 20 00



**SECTION 06 41 00
ARCHITECTURAL WOOD CASEWORK**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Specially fabricated cabinet units.
- B. Countertops.
- C. Hardware.

1.2 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry: Support framing, grounds, and concealed blocking.

1.3 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition 2014, with Errata (2016).
- B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards, U.S. Version 4.0 2021, with Errata.
- C. BHMA A156.9 - Cabinet Hardware 2020.
- D. NEMA LD 3 - High-Pressure Decorative Laminates 2005.
- E. WI (CCP) - Certified Compliance Program (CCP) Current Edition.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Furnish a Woodwork Institute Certified Compliance Label on the first page of the shop drawings
- C. Product Data: Provide data for hardware accessories.
- D. Samples: Submit actual samples of architectural cabinet construction, minimum 12 inches (300 mm) square, illustrating proposed cabinet, countertop, and shelf unit substrate and finish.
- E. Certificate: Submit labels and certificates required by quality assurance and quality control programs.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
 - 1. Company with at least one project in the past 5 years with value of woodwork within 20 percent of cost of woodwork for this Project.
 - 2. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.
 - 3. Single Source Responsibility: Provide and install this work from single fabricator.
- B. Quality Certification:
 - 1. Comply with WI (CCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: <https://woodworkinstitute.com>.
 - 2. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 3. Provide designated labels on shop drawings as required by certification program.
 - 4. Provide designated labels on installed products as required by certification program.
 - 5. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.
 - 6. Replace, repair, or rework all work for which certification is refused.



1.6 CERTIFIED COMPLIANCE:

- A. Before delivery to the job site, provide a Woodwork Institute Certified Compliance Certificate indicating the millwork products being supplied and Certifying that these products fully meet the requirements of the NAAWS Grade or Grades specified.
- B. Provide a Woodwork Institute Certified Compliance Label on each elevation of casework.
- C. At completion of installation provide a Woodwork Institute Certified Compliance Certificate indicating the products installed, and certifying that the installation of these products fully meets the requirements of the NAAWS Grade or Grades specified.
- D. All fees charged by the Woodwork Institute for its Certified Compliance program are the responsibility of the millwork manufacturer and/or installer and shall be included in their bid.

1.7 CODE REQUIREMENTS

- A. Casework:
 - 1. Operable parts for all accessible casework shall comply with **CBC Section 11B-309**.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from moisture damage.

PART 2 - PRODUCTS

2.1 CABINETS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Plastic Laminate Faced Cabinets: Custom grade.

2.2 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.
- B. Lumber: In accordance with the North American Architectural Woodwork Standards Grade specified for the product being fabricated. Moisture Content: 6% to 12% for boards up to 2-inch (50.8 mm) nominal thickness, and shall not exceed 19% for thicker pieces.
- C. Core: MDF or Particleboard meeting the requirements of North American Architectural Woodwork Standards.
 - 1. Made with no added urea formaldehyde CARB compliant.
 - 2. Water-resistant core, where required: Particle board meeting the requirements of ANSI A208.1 Grade M3 MR-50 or MDF meeting the requirements of ANSI A 208.2 Grade 155 MR-50.

2.3 LAMINATE MATERIALS

- A. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.
- B. Provide specific types as indicated.
 - 1. Horizontal Surfaces: HGS, 0.048 inch (1.22 mm) nominal thickness, through color, color as selected, satin finish.
 - 2. Vertical Surfaces: VGS, 0.028 inch (0.71 mm) nominal thickness, through color, color as selected, satin finish.
 - 3. Cabinet Liner: NEMA LD-3 Grade CLS, 0.020 inch (0.51 mm) nominal thickness, through color, satin finish.

2.4 COUNTERTOPS

- A. Plastic Laminate Countertops: Medium density fiberboard substrate covered with HPDL, conventionally fabricated and self-edge banded.

2.5 ACCESSORIES

- A. Adhesive: Type recommended by fabricator to suit application.



- B. Fasteners: Size and type to suit application.
- C. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.
- D. Grommets: Standard plastic, painted metal, or rubber grommets for cut-outs, in color to match adjacent surface.

2.6 HARDWARE

- A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.
- B. Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards or multiple holes for pin supports and coordinated self rests, polished chrome finish, for nominal 1 inch spacing adjustments.
 - 1. Product: Shelf Support equal to "Hettich" 'SEKURA 1" shelf support, nickle-plated, 5mm pin, die-cast zinc.
- C. Drawer and Door Pulls: "U" shaped wire pull, steel with chrome finish, 4 inch centers ("U" shaped wire pull, steel with chrome finish, 100 mm centers).

- D. Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, steel with chrome finish.
 - 1. All cabinets shall have locks.
 - a. One key opens all locks in the building (Master per building).
 - b. One key opens all locks in one particular class room or office (sub-master per room).
 - c. One key opens only the cabinet that the individual numbered lock is on (operator).
 - d. Key all of the cabinets seperately but have a Master, Sub-Master and Operator key applied to the setup.
- E. Cabinet Catches and Latches: Magnetic
- F. Drawer Slides:
 - 1. File drawers: Full extension. Minimum 100-pound capacity except 150-pound capacity for lateral files.
 - 2. Manufacturers:
 - a. Accuride International, Inc; Heavy-Duty Drawer Slides: www accuride.com.
 - b. Knap & Vogt Manufacturing Company; Heavy-Duty Drawer Slides: www.knapandvogt.com.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- G. Hinges: European style concealed self-closing type, steel with nickel-plated finish.
 - 1. Five-knuckle Grade 1 hinges. Concealed European style Grade II hinges minimum 120 degree opening.
- H. Keyboard Tray: Integral ball-bearing slides; adjustable tilt, gel palm rest, storage compartments, cable management, and mouse pad.
 - 1. Manufacturers:
 - a. Accuride International, Inc; CBERGO-TRAY 300: www accuride.com.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.7 FABRICATION

- A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.
- B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.
- C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
- D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate



counter butt joints minimum 2 feet from sink cut-outs. (Locate counter butt joints minimum 600 mm from sink cut-outs.)

1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
2. Cap exposed plastic laminate finish edges with material of same finish and pattern.

- E. Mechanically fasten back splash to countertops as recommended by laminate manufacturer at 16 inches (400 mm) on center.
- F. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify location and sizes of utility rough-in associated with work of this section.

3.2 INSTALLATION

- A. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.
- B. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.
- C. Use concealed joint fasteners to align and secure adjoining cabinet units.
- D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch (0.79 mm). Do not use additional overlay trim for this purpose.
- E. Secure cabinets to floor using appropriate angles and anchorages.
- F. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.
- G. Sink Skirts to be hinged and locked and shall provide access to all concealed items for maintenance without special tools or knowledge.

3.3 ADJUSTING

- A. Adjust installed work.
- B. Adjust moving or operating parts to function smoothly and correctly.

3.4 CLEANING

- A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION 06 41 00

**SECTION 07 14 00
FLUID-APPLIED WATERPROOFING**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cold-applied rubberized asphalt waterproofing.
- B. Acrylic waterproofing.
- C. Under-tile waterproofing and anti-fracture membrane.

1.2 REFERENCE STANDARDS

- A. ANSI A118.10 - American National Standard Specifications for Load Bearing, Bonded, Waterproof Membranes For Thin-Set Ceramic Tile And Dimension Stone Installation 2014.
- B. ASTM C836/C836M - Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course 2018.
- C. ASTM C1306/C1306M - Standard Test Method for Hydrostatic Pressure Resistance of a Liquid-Applied Waterproofing Membrane 2008, with Editorial Revision (2016).
- D. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension 2016 (Reapproved 2021).
- E. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials 2016.
- F. ASTM E154/E154M - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover 2008a (Reapproved 2019).
- G. ICC-ES AC29 - Acceptance Criteria for Cold, Liquid-Applied, Below-Grade, Exterior Dampproofing and Waterproofing Materials 2011, with Editorial Revision (2014).
- H. NRCA (WM) - The NRCA Waterproofing Manual 2005.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for membrane, surface conditioner, flexible flashings, joint cover sheet, and joint and crack sealants.
- C. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.
- D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and acceptable installation temperatures.
- E. Warranty Documentation:
 - 1. Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least five years of documented experience.

1.5 FIELD CONDITIONS

- A. Maintain ambient temperatures above 40 degrees F (5 degrees C) for 24 hours before and during application and until cured.

1.6 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.



PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Cold-Applied Rubberized Asphalt Waterproofing:
 - 1. AVM Industries, Inc; AVM System 500 (Aussie Membrane): www.avmindustries.com.
 - 2. EPRO Services, Inc: www.eproinc.com.
 - 3. NaturaSeal; SpraySeal NS-F300+GE (Geotextile): www.naturaseal.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Acrylic Waterproofing:
 - 1. Mar-flex Waterproofing & Building Products: www.mar-flex.com.
 - 2. Rust-Oleum Corporation; SEAL-KRETE Heavy-Duty Concrete & Masonry Waterproofer: www.rustoleum.com.
- C. Under-Tile Waterproofing and Anti-Fracture Membrane:
 - 1. AVM Industries, Inc: www.avmindustries.com.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 FLUID-APPLIED WATERPROOFING APPLICATIONS

- A. Cold-Applied Rubberized Asphalt Waterproofing:
- B. Acrylic Waterproofing:
- C. Under-Tile Waterproofing and Anti-Fracture Membrane:

2.3 FLUID-APPLIED WATERPROOFING MATERIALS

- A. Cold-Applied Rubberized Asphalt Waterproofing: Rubberized asphaltic compound, suitable for installation on concrete and concrete masonry.
 - 1. Cured Thickness: 60 mil, 0.060 inch (1.52 mm), minimum.
 - 2. Comply with ICC-ES AC29 acceptance criteria.
 - 3. Hydrostatic Pressure Resistance: Tested in accordance with ASTM C1306/C1306M, 50 psi (340 kPa), minimum by rapid test, and 35 psi (240 kPa), minimum by long term test.
 - 4. Low Temperature Resistance: No cracking, loss of adhesion, splitting or pinholes when tested at minus 15 degrees F (minus 26 degrees C) in accordance with ASTM C836/C836M.
 - 5. Decay Resistance: No decay when tested in accordance with ASTM E154/E154M.
 - 6. Wet Film Sag Resistance: Maximum sag within plus/minus 5 mils (0.1 mm) when tested in accordance with ASTM C836/C836M.
 - 7. Water Vapor Permeance: 1 perm (57 ng/(Pa s sq m)), maximum, when tested in accordance with ASTM E96/E96M.
 - 8. Heat Aging Resistance: No cracking, splitting, or pinholes when tested in accordance with ASTM C836/C836M.
 - 9. Elongation at Break: 1,000 percent, minimum, when tested in accordance with ASTM D412.
 - 10. Products:
 - a. AVM Industries, Inc: www.avmindustries.com.
 - b. EPRO Services, Inc: www.eproinc.com.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Acrylic Waterproofing: Water-based, 100 percent acrylic.
 - 1. Cured Thickness: 60 mil, 0.060 inch (1.52 mm), minimum.
- C. Under-Tile Waterproofing and Anti-Fracture Membrane: Specifically designed for bonding to concrete, backer boards, and plywood under ceramic tile; complying with ANSI A118.10.
 - 1. Material: Trowel-applied water-based acrylic membrane, 25 mil, 0.025 inch (0.63 mm) thick, minimum, with continuous polyester fabric reinforcement.
 - 2. Products:
 - a. AVM Industries, Inc: www.avmindustries.com.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.4 ACCESSORIES

- A. Surface Conditioner: Primer type, compatible with membrane compound; as recommended by membrane manufacturer.
- B. Sealant for Joints and Cracks in Substrate: Type compatible with waterproofing material and as recommended by waterproofing manufacturer.
- C. Drainage Panel: Drainage layer with geotextile filter fabric on earth side.
 - 1. Composition: Dimpled polyethylene, polypropylene, or polystyrene core; polypropylene or polyester filter fabric.
 - 2. Thickness: As indicated on drawings.
 - 3. Products:
 - a. Mar-flex Waterproofing & Building Products; ArmorDrain 110: www.mar-flex.com.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Counterflashings: As recommended by membrane and protection board manufacturer.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify substrate surfaces are free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of waterproofing system.
- C. Verify that substrate surfaces are smooth, free of honeycomb or pitting, and not detrimental to full contact bond of waterproofing materials.
- D. Verify that items penetrating surfaces to receive waterproofing are securely installed.

3.2 PREPARATION

- A. Protect adjacent surfaces from damage not designated to receive waterproofing.
- B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions; vacuum substrate clean.
- C. Do not apply waterproofing to surfaces unacceptable to waterproofing manufacturer.
- D. Fill non-moving joints and cracks with a filler compatible with waterproofing materials.
- E. Seal moving cracks with sealant and non-rigid filler, using procedures recommended by sealant and waterproofing manufacturers.
- F. Prepare building expansion joints at locations as indicated on drawings.
- G. Install cant strips at inside corners.

3.3 INSTALLATION

- A. Install waterproofing to specified minimum thickness in accordance with manufacturers instructions and NRCA (WM) applicable requirements.
- B. Apply primer or surface conditioner at a rate recommended by manufacturer, and protect conditioner from rain or frost until dry.
- C. At joints and cracks less than 1/2 inch (13 mm) in width including joints between horizontal and vertical surfaces, apply 12 inch (300 mm) wide strip of joint cover sheet.
- D. Apply extra thickness of waterproofing material at corners, intersections, and angles.
- E. Flexible Flashings: Seal items watertight that penetrate through waterproofing membrane with flexible flashings.
- F. Seal membrane and flashings to adjoining surfaces.



3.4 INSTALLATION - DRAINAGE PANEL AND PROTECTION BOARD

- A. Place drainage panel directly against membrane, butt joints, place to encourage drainage downward, and scribe and cut boards around projections, penetrations, and interruptions.

3.5 PROTECTION

- A. Do not permit traffic over unprotected or uncovered membrane.

END OF SECTION 07 14 00

**SECTION 07 19 00
WATER REPELLENTS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Water repellents applied to exterior, masonry, stone, and concrete surfaces.
- B. Pressure washing.

1.2 REFERENCE STANDARDS

- A. ASTM C140/C140M - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units 2022a.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, details of tests performed, limitations, and chemical composition.
- C. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention; cautionary procedures required during application.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.
- B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience

1.5 MOCK-UP

- A. Prepare representative surface 36 by 36 inches (0.91 by 0.91 m) in size using specified materials and preparation and application methods on surfaces identical to those to be coated; approved mock-up constitutes standard for workmanship.
- B. Locate where directed.
- C. Mock-up may remain as part of the Work.

1.6 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Silane, Siloxane, Silane-Siloxane Blend, and Siliconate Water Repellents:
 - 1. BASF Construction Chemicals: www.buildingsystems.basf.com.
 - 2. Concrete Sealers USA: www.concretesealersusa.com.
 - 3. Dayton Superior Corporation: www.daytonsuperior.com.
 - 4. Pecora Corporation; KlereSeal 910-W/920-W Water-Based Penetrating Masonry Sealer : www.pecora.com.
 - 5. PPG Paints: www.ppgpaints.com.
 - 6. PROSOCO, Inc: www.prosoco.com.
 - 7. QUIKRETE Companies: www.quikrete.com.
 - 8. Textured Coatings of America, Inc: www.texcote.com.
 - 9. Tnemec Company, Inc: www.tnemec.com.
 - 10. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 MATERIALS

- A. Water Repellent: Non-glossy, colorless, penetrating, water-vapor-permeable, non-yellowing sealer, that dries invisibly leaving appearance of substrate unchanged.
 - 1. Applications: Vertical surfaces and non-traffic horizontal surfaces.
 - 2. Number of Coats: Two.
 - 3. Moisture Absorption When Applied to Masonry: Five percent, maximum, when tested in accordance with ASTM C140/C140M using masonry sample completely coated with water repellent.
 - 4. Silane, siloxane, silane-siloxane blend, or silicate that reacts chemically with concrete and masonry.
 - a. Manufacturers:
 - 1) Advanced Chemical Technologies, Inc; SIL-ACT ATS-100, with VOC of 350 g/L or less: www.advchemtech.com.
 - 2) Dayton Superior Corporation: www.daytonsuperior.com.
 - 3) PROSOCO, Inc; Consolideck SL100 Water Repellent, with VOC of 400 g/L or less: www.prosoco.com.
 - 4) Substitutions: See Section 01 60 00 - Product Requirements.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify joint sealants are installed and cured.
- C. Verify surfaces to be coated are dry, clean, and free of efflorescence, oil, or other matter detrimental to application of water repellent.

3.2 PREPARATION

- A. Protection of Adjacent Work:
 - 1. Protect adjacent landscaping, property, and vehicles from drips and overspray.
 - 2. Protect adjacent surfaces not intended to receive water repellent.
- B. Prepare surfaces to be coated as recommended by water repellent manufacturer for best results.
- C. Do not start work until masonry mortar substrate is cured a minimum of 60 days.
- D. Remove loose particles and foreign matter.
- E. Remove oil and foreign substances with a chemical solvent that will not affect water repellent.
- F. Scrub and rinse surfaces with water and let dry.
- G. Pressure wash surfaces to be coated.
 - 1. Concrete: High pressure wash at 1,500 to 4,000 psi (10 to 30 MPa), at 6 to 12 inches (150 to 300 mm) from surface.
 - 2. Firm Masonry (Concrete Masonry Units, Brick, and Dense Stone): High pressure wash at 1,500 to 4,000 psi (10 to 30 MPa), at 6 to 12 inches (150 to 300 mm) from surface.
 - 3. Weathered Masonry (Brick and Stone): Pressure wash at 600 to 1,500 psi (4 to 10 MPa) at 6 inches (150 mm) from surface.
 - 4. Soft Stone (Sandstone and Limestone): Power wash at 100 to 600 psi (1 to 4 MPa) at 6 inches (150 mm) from surface.
- H. Allow surfaces to dry completely to degree recommended by water repellent manufacturer before starting coating work.

3.3 APPLICATION

- A. Apply water repellent in accordance with manufacturer's instructions, using procedures and application methods recommended as producing the best results.
- B. Apply at rate recommended by manufacturer, continuously over entire surface.



- C. Apply two coats, minimum.
- D. Remove water repellent from unintended surfaces immediately by a method instructed by water repellent manufacturer.

END OF SECTION 07 19 00

**SECTION 07 21 00
THERMAL INSULATION**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Batt insulation and vapor retarder in exterior wall and roof construction.
- B. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.

1.2 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- B. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C 2019a.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

PART 2 - PRODUCTS

2.1 APPLICATIONS

- A. Insulation on Inside of Concrete and Masonry Exterior Walls: Glass fiber board.
- B. Insulation in Wood Framed Walls: Batt insulation with integral vapor retarder.

2.2 FIBERBOARD INSULATION MATERIALS

- A. Where fiberboard insulation is indicated, either rock, slag, or glass mineral fiberboard insulation may be used, at Contractor's option.
- B. Mineral Fiberboard Insulation: Rigid mineral fiber, in accordance with ASTM C612.
 - 1. Flame Spread Index: 25 or less, when tested with facing, if any, in accordance with ASTM E84.
 - 2. Smoke Developed Index: 50 or less, when tested with facing, if any, in accordance with ASTM E84.
 - 3. Board Thickness: 1 inch (25.4 mm).
 - 4. Products:
 - a. CertainTeed Corporation: www.certainteed.com.
 - b. Johns Manville: www.jm.com.
 - c. Owens Corning Corporation: www.ocbuildingspec.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 BATT INSULATION MATERIALS

- A. Where batt insulation is indicated, either glass fiber or mineral fiber batt insulation may be used, at Contractor's option.
- B. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.
 - 1. Flame Spread Index: 75 or less, when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
 - 3. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
 - 4. Formaldehyde Content: Zero.
 - 5. Facing: Aluminum foil, flame spread 25 rated; one side.
 - 6. Products:
 - a. CertainTeed Corporation: www.certainteed.com.
 - b. Johns Manville: www.jm.com.



- c. Owens Corning Corporation; EcoTouch PINK FIBERGLAS Insulation:
www.ocbuildingspec.com.
- d. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Mineral Fiber Batt Insulation: Flexible or semi-rigid preformed batt or blanket, complying with ASTM C665; friction fit; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84.
 - 1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.
 - 3. Products:
 - a. Johns Manville; MinWool Sound Attenuation Fire Batts: www.jm.com.
 - b. ROCKWOOL (ROXUL, Inc); COMFORTBATT: www.rockwool.com.
 - c. Thermafiber, Inc; SAFB: www.thermafiber.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

2.4 ACCESSORIES

- A. Insulation Fasteners: Appropriate for purpose intended.
 - 1. Length as required for thickness of insulation material and penetration of deck substrate.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
- B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.2 BATT INSTALLATION

- A. Install insulation and vapor retarder in accordance with manufacturer's instructions.
- B. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
- E. Install with factory-applied vapor retarder membrane facing warm side of building spaces. Lap ends and side flanges of membrane over framing members.
- F. Staple or nail facing flanges in place at maximum 6 inches (152 mm) on center.
- G. Tape seal butt ends, lapped flanges, and tears or cuts in membrane.
- H. Tape seal tears or cuts in vapor retarder.
- I. Extend vapor retarder tightly to full perimeter of adjacent window and door frames and other items interrupting the plane of the membrane; tape seal in place.

3.3 PROTECTION

- A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION 07 21 00



SECTION 07 21 26
BLOWN INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Exterior Walls: Blown insulation pneumatically placed into wall spaces through access holes.
- B. Ceiling and Attic: Blown insulation pneumatically placed into joist spaces through access holes.

1.2 REFERENCE STANDARDS

- A. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. ASTM C764 - Standard Specification for Mineral Fiber Loose-Fill Thermal Insulation 2019.
- C. ASTM C1015 - Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill Thermal Insulation 2017.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, and limitations.
- C. Certificates: Certify that products of this section meet or exceed specified requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Blown Insulation:
 - 1. CertainTeed Corporation: www.certainteed.com.
 - 2. Johns Manville: www.jm.com.
 - 3. Thermafiber, Inc: www.thermafiber.com.

2.2 MATERIALS

- A. Applications: Provide blown insulation in attic, exterior walls, and ceiling as indicated on drawings.
- B. Provide blown insulation in accordance with requirements of Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- C. Thermal Resistance [R-value (RSI-value)]: Provided minimum values in accordance with applicable edition of ASHRAE Std 90.1 I-P for envelope requirements of building location and climate zone.
- D. Blown Insulation: ASTM C764, fiberglass type, nodulated for pour and bulk for pneumatic placement.
 - 1. Thermal Resistance (R-value (RSI-value)): 11.0 sq ft hr deg F/BTU inch (1.9372 sq m K/W inch), minimum.

2.3 ACCESSORIES

- A. Roof Ventilation Baffles: Prefabricated ventilation channels for placement under roof sheathing with baffles to prevent wind-washing.
 - 1. Material: Polyvinyl chloride (PVC).
 - 2. Roof Joist/Truss Spacing: 16 inch (406 mm) on center, nominal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that substrate and adjacent materials are dry and ready to receive insulation.
- B. Verify that light fixtures have thermal cut-out device to restrict over-heating in soffit or ceiling spaces.
- C. Verify spaces are unobstructed to allow for proper placement of insulation.



3.2 INSTALLATION

- A. Install insulation and ventilation baffle in accordance with ASTM C1015 and manufacturer's instructions.
- B. Place insulation pneumatically to completely fill stud, joist, and rafter spaces.
- C. Place insulation against baffles, and do not impede natural attic ventilation to soffit.
- D. Completely fill intended spaces leaving no gaps or voids.
- E. Repair and reseal insulation access ports and refinish to match adjacent work.

3.3 CLEANING

- A. Remove loose insulation residue.

END OF SECTION 07 21 26



SECTION 07 41 13
METAL ROOF PANELS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Preformed metal roofing panels, **[standing] [batten]** seam.
- B. Gutters and downspouts.
- C. Flashings, trim, closures, fasteners, sealants, and other accessory items.
- D. Insulation.
- E. Gypsum cover board.

1.2 RELATED SECTIONS

- A. As applicable

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. ASTM A792/A792M – Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - 2. ASTM A924/A924M – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot Dip Process.
 - 3. ASTM C1177/C1177M – Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
 - 4. ASTM C1289 – Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
 - 5. ASTM C1371 – Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
 - 6. ASTM C1549 – Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
 - 7. ASTM D226 – Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
 - 8. ASTM D1056 – Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber.
 - 9. ASTM D1970 – Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
 - 10. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 11. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials.
 - 12. ASTM E108 – Standard Test Methods for Fire Tests of Roof Coverings.
 - 13. ASTM E408 – Standard Test Method for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
 - 14. ASTM E1918 – Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-sloped Surfaces in the Field.
 - 15. CAN/ULC S770 – Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams.



1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Indicate layout including dimensions, sizes, and components. Show details of anchoring, closure, clips, trims, and accessories. Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions. Show interface with adjacent surfaces.
- C. Product Data: Submit product data for each product specified in this Section with the product and selected attributes clearly identified.
- D. Samples: Submit two 12 inch by 12 inch panel samples for each material, finish, and color specified.
 - 1. Physical sample requirements shall be waived if the Basis-of-Design product is submitted.

1.5 PERFORMANCE REQUIREMENTS

- A. Movement: Accommodate movement within roof panel system including perimeter components without damage to components or deterioration of seals when subjected to seasonal temperature cycles, dynamic loading and release of loads, and deflection of structural support framing.
- B. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel systems.
- C. Thermal: Provide continuity of thermal barrier at building closure elements in conjunction with thermal insulating materials.

1.6 SUSTAINABLE BUILDING DESIGN REQUIREMENTS

- A. Provide highly reflective Energy Star® compliant roofing system with emissivity of at least 0.9 when tested in accordance with ASTM E408 for a minimum of 75 percent of the roof surface.
 - 1. Thermal emissivity shall be measured in accordance with ASTM C1371.
 - 2. Solar Reflectivity shall be measured in accordance with ASTM C1549.
 - 3. Solar Reflectance Index shall be measured in accordance with
- B. Provide insulation products manufactured free from environment-harmful blowing agents chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC).

1.7 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer Qualifications: Firm specializing in manufacturing products specified in this Section with a minimum ten years' experience.
 - 2. Installer Qualifications: Firm specializing in installing work specified in this Section directly employed by manufacturer or acceptable to manufacturer with experience on at least five projects of similar nature in past three years.
- B. Requirements of Regulatory Agencies:
 - 1. Metal roofing systems shall be Class A per CBC Section 1505.
 - 2. Metal roofing systems shall meet or exceed the wind uplift requirements for the location of the installation as per CBC.
 - 3. Metal roofing systems installed on this project shall have a current and valid ICC ES Evaluation Report.
- C. Pre-Installation Meetings:
 - 1. Conduct pre-installation meeting in accordance with provisions of Division 01.
 - 2. Convene pre-installation meeting one week prior to commencing work of this Section.
 - 3. Coordinate work in this Section with work in related Sections.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products under provisions of Division 01.
- B. Provide adequate protection so material is not exposed to weather or moisture prior to erection.

- C. Units of panels that become deformed or damaged from any cause whatsoever, to the extent that they are weakened or unsuitable for use as part of the finish surface, shall be replaced unless they can be repaired to the satisfaction of Architect.
- D. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
- E. Store pre-finished material off the ground, protected from weather to prevent twisting, bending or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- F. Prevent contact with materials capable of causing discoloration or staining.

1.9 WARRANTIES

- A. Immediately upon acceptance of roofing work at the time of Final Project Completion, the Contractor, metal panel installer and metal panel manufacturer shall execute and deliver to Owner, the following Guarantees/Warrantees:
 - 1. Forty year unlimited Penal Sum Warrantee for material failure and finish failure (cracking, checking, blistering, peeling, flaking, chipping, chalking, and fading) by metal panel manufacturer for all panel systems specified in this Section.
 - 2. Two year watertightness Guarantee/Warrantee by Contractor and Metal Panel Installer warranting panels, flashings, sealants, fasteners and accessories against defective materials and workmanship, to remain watertight and weatherproof:
 - a. Emergency repairs shall be made within 24 hours notice by Owner of leakage or defect. As soon as weather permits, affected areas shall be permanently restored to standards of quality, i.e. workmanship, durability and appearance called for in the Contract Documents. Emergency repairs shall be made without any charge to the Owner. The value of this Agreement shall not be limited to a specific maximum sum. Owner maintenance shall not be required as a condition to continuation of this Agreement in force for two years.
 - b. Excluded from this Agreement are leaks or defects caused by abuse, vandalism, extraordinary roof deck movement, fire or other casualty.
 - 3. Twenty year watertightness Guarantee/Warranty by metal panel manufacturer for all panel systems specified in this Section.
 - a. Emergency repairs shall be made within 24 hours notice by Owner of leakage or defect. As soon as weather permits, affected areas shall be permanently restored to standards of quality, i.e. workmanship, durability and appearance called for in the Contract Documents. Emergency repairs shall be made without any charge to the Owner. The value of this Agreement shall not be limited to a specific maximum sum.
- B. Warranty includes removal, replacement, repair, and making good without cost to the Owner, of defects due to defective materials or workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

- A. Acceptable Manufacturers:
 - 1. AEP Span, West Sacramento, CA; 800-733-4955, www.aepspan.com. Products:
 - 2. MBCI, Atwater, CA; 800-829-9324, www.mbc.com.
 - 3. Carlisle Metal Products, Carlisle, PA; 800-479-6832, www.carlislemetalproducts.com.
 - 4. Metal Sales Manufacturing Corporation, Louisville, KY; 800-406-7387, www.metalsales.us.com.
 - 5. Morin, a Kingspan Group Company, Bristol, CT; 800-640-9501, www.morincorp.com.
 - 6. Firestone Metal Products LLC, Anoka, MN; 800-426-7737, www.firestonemetal.com.
 - 7. Taylor Metal Products, Salem, OR; 800-574-1388, www.taylormetal.com.
 - 8. The Garland Company, Inc., Cleveland, OH; 800-321-9336, www.garlandco.com.
- B. Substitutions: Under provisions of Division 01.

2.2 METAL ROOF PANELS

- A. Metal Standing Seam Roofing System: Pre-finished, **[standing] [batten]** seam; concealed anchors that resist wind uplift yet permits expansion and contraction with temperature changes.

- B. Base Metal: Min. 22 gauge steel sheet, aluminum-zinc alloy coated by hot-dipped process conforming to ASTM A792/A792M and ASTM A924/A924M, minimum AZ50 coating, minimum yield strength of 40 ksi.

2.3 ACCESSORIES AND RELATED MATERIALS

- A. Fasteners, Clips, Cleats, Thermal Spacer, Flat Bearing Plate: Corrosion-resistant type as provided by manufacturer to complete a concealed anchorage system and to ensure a water and weatherproof installation. Fasten clips over flat bearing plates over rigid insulation. Exposed gutter rivets shall be finished to match roofing material.
- B. Closures: Metal or black closed cell pre-molded neoprene or polyethylene foam meeting ASTM D1056 grade SCE-41 Black EPT.
- C. Flashings, Trims, Gutters and Downspouts: Same gauge, material and finish as metal roof. Profile as shown on Drawings.
- D. Downspout Strainer: Wire strainer, same basic material as gutter.
- E. Rigid Insulation: Closed-cell polyisocyanurate foam core integrally laminated to heavy black (non-asphaltic), fiber-reinforced felt facers with square edges; conforming to ASTM C1289, Type II, Class 1; Grade 2 (20 psi minimum compressive strength); surface burning characteristics: flame spread 25 to 50 and smoke developed 50 to 170 per ASTM E84; long-term thermal resistance (LTTR) value minimum 5.5 F-hr-SqFt / Btu / inch at 75 degrees F per CAN/ULC-S770; thickness as indicated on Drawings.
 - 1. Acceptable Products:
 - a. AC Foam-II by Atlas Roofing Corp., Atlanta, GA; 770-952-1442, www.atlasroofing.com.
 - b. Multi-Max FA-3 by Rmax, Inc., Dallas, TX; 800-527-0890, www.rmaxinc.com.
 - c. ISO 95+ by Firestone Building Products, Indianapolis, IN; 800-428-4442, www.firestonebpco.com.
 - d. or accepted equal.
- F. Gypsum Cover Board: Glass mat-faced, noncombustible, moisture-resistant treated gypsum core panel; 1/2 inch thick, square edges; conforming to ASTM C1177.
 - 1. Product: DensDeck by Georgia-Pacific Gypsum LLC, Atlanta, GA; 404-652-4000, www.gp.com, or accepted equal.
- G. Premium Underlayment: Self-adhering, cold-applied rubberized asphalt membrane; maximum water vapor permeance 0.05 perms per ASTM E96.
 - 1. Product: Grace Ultra by Grace Construction Products, Cambridge, MA; 866-333-3726, www.na.graceconstruction.com, or accepted equal.
- H. Sealant: Type specified in Section 07 92 00.

2.4 FABRICATION

- A. Form sections to configuration indicated on Drawings, accurate in size, square and free from distortion or defects.
- B. Fabricate panel pieces in longest practicable lengths; one piece lengths wherever possible.
- C. Fabricate flashings, trim, gutters, downspouts, and accessories in longest practical lengths.
- D. Sheet Metal Flashing and Trim: Form from materials matching metal panel substrate and finish, unless noted otherwise on Drawings. Fabricate flashing and trim to comply with manufacturer's written instructions, accepted shop drawings, project drawings, and as specified in Section 07 62 00.

2.5 FINISH

- A. Factory Finish:
 - 1. Exposed Face:
 - a. DuraTech 5000 Polyvinylidene Fluoride (PVDF) paint system consisting of a baked-on 0.2 mil thick corrosion-resistant primer and a baked-on 0.8 mil thick finish coat containing 70 percent Kynar 500/Hylar 5000 resins for total coating of 1.0 mil dry film thickness.
 - b. Dura Tech mx Premium Polyvinylidene Fluoride (PVDF) metallic paint system consisting of a baked-on 0.15 mil to 0.2 mil thick corrosion-resistant primer and a baked-on Polyvinylidene

Fluoride 0.70 mil to 0.80 mil thick finish coat for total coating of 0.85 mil to 1.0 mil dry film thickness with a specular gloss of 20 to 35 when tested in accordance with ASTM D523 at 60 degrees.

- c. Or approved equivalent
 2. Concealed Face: Corrosion-resistant primer coat with 0.15 mils dry film thickness and finish coat of polyester paint with 0.35 mils dry film thickness for total coating of 0.50 mil dry film thickness.
 3. All dry film thickness measurements shall be in accordance with ASTM D1005.
- B. Color **[as indicated on Drawings] [as selected by Architect from manufacturer's full range of colors]**, meeting "Cool Roof" requirements, with the following values:
1. Solar Reflectance Index (SRI): 53 per ASTM E1918.
 2. Solar Reflectivity Value (SRV): 0.59 per ASTM C1549.
 3. Emissivity: 0.79 per ASTM C1371.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify supporting substrate surfaces are ready to receive panel system. Surfaces in contact with panels shall be free from debris or objects that may damage panels.
- B. Report unacceptable conditions to Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 INSTALLATION

- A. Workmanship: All work shall be neat, trim, true to line and, upon completion, shall present a true finished surface of the specified profile, free of dents, deformations, creases or other noticeable defects.
- B. Protection:
 1. Treat, or isolate with protective material, any contacting surfaces of dissimilar materials to prevent electrolytic corrosion.
 2. Require workmen working on roofing panels to wear clean, soft-soled shoes that will not pick up stones or other abrasive material which could damage or discolor panel surface.
 3. Protect work of other trades from damage.
- C. Insulation Installation:
 1. Lay multiple layers of roof insulation to achieve thickness as indicated on Drawings in accordance with manufacturer's instructions. Stagger joints of layers.
 2. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
 3. Apply no more insulation than can be covered with roof panels in same day.
 4. Tape joints of insulation in accordance with insulation manufacturer's instructions.
- D. Gypsum Cover Board Installation:
 1. Place cover board over clean insulation.
 2. Fasten with disk-type fasteners as recommended by cover board manufacturer.
 3. Stagger all joints a minimum of 6 inches from underlying insulation joints.
- E. Underlayment Installation:
 1. Install premium underlayment **[over entire area to receive metal roof panels] [at critical areas including, but not limited to, valleys, ridge, rake edge, eaves (ice dams), hip, curbs, confined rake edge, roof penetrations, and skylights]** under provisions of Applicable Section(s).
- F. Metal Roof Panel Installation:
 1. Install roofing anchorage and all accessories strictly in accordance with Current ICC ES Report, manufacturer's instructions, and approved shop drawings.
 2. Remove any strippable protective coating on the panels and flashings prior to installation and in any case do not allow the strippable coating to remain on the panels in extreme heat, cold or in direct sunlight or other UV source.
 3. Lap panels away from prevailing wind direction.



4. Attach panels to substrate with clips and fasteners. Set clips in bed of compatible weather barrier sealant over underlayment facer. Seal fastener heads with sealant. Secure panels without warp or deflection. Install to allow for thermal movement.
 - a. The length of all fasteners that extend through the **[steel]** **[wood]** decking shall be such that the end of the fastener is six threads or 1/2 inch past the bottom of the decking, whichever is longer.
 5. Install flashings to allow for thermal movement.
 6. Attach flashings and trim pieces with mechanical fasteners and sealant.
 7. Install all closures as indicated or required for a watertight installation.
 8. Perforations/punctures of roof panels are not permitted, except as required for anchoring and installation of trims and flashings.
- G. Gutters: Join sections with riveted and soldered joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches on center using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion at least every 50 feet, and not more than 25 feet from rigid corners or intersections. Install expansion joint caps. Provide slope to drain at 1/16 inch per foot to gutter outlets connected to downspouts.
- H. Downspouts: Join sections with telescoping joints. Lap joints in direction of flow. Fasten using straps, anchors, and spacers as required. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches on center in between. Mechanically fasten gutter outlet connections in place and fully solder weathertight.

3.3 ERECTION TOLERANCES

- A. Maximum alignment variation: 1/4 inch in 40 feet.
- B. Maximum variation from plane or location indicated on the Drawings: 1/4 inch.

3.4 ADJUST AND CLEAN

- A. Cleaning and Finishing: Upon completion of the work clean all exposed surfaces with mild soap and water, removing any discoloration or foreign matter. Touch up all abraded or cut areas and exposed edges with finishing material recommended by the manufacturer. Touch-up shall not be noticeable when viewed from ten feet.
- B. Defective Work: Remove and replace any defective work which cannot be properly repaired, cleaned or touched up, as directed by Architect, with no cost to Owner.
- C. Protect all installed work against damage from other construction work.

3.5 CLEAN UP

- A. Upon completion of the work of this Section, remove all surplus materials, rubbish and debris from the premises. Contractor shall thoroughly clean entire roof area at completion of project.

END OF SECTION 07 41 13

SECTION 07 54 19
PVC THERMOPLASTIC SINGLE-PLY ROOFING

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Installation of a single ply PVC roofing membrane with flashings and other components to comprise a complete roofing system.

1.2 REFERENCE STANDARDS

- A. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; current edition.
- B. ASTM D4434/D4434M - Standard Specification for Poly(Vinyl Chloride) Sheet Roofing; current edition.
- C. NRCA (RM) - The NRCA Roofing Manual; current edition.
- D. NRCA ML104 - The NRCA Roofing and Waterproofing Manual; National Roofing Contractors Association; Fifth Edition, with interim updates.
- E. UL 790 - Standard for Standard Test Methods for Fire Tests of Roof Coverings; Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. See Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's written information listed below.
 - 1. Product data indicating membrane materials, flashing materials and fasteners.
- C. Installer's Qualification Statement.
- D. Specimen Warranty: For approval.
- E. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, and supplementary instructions given.
- F. Warranty:
 - 1. Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
 - 2. Submit installer's certification that installation complies with all warranty conditions for the waterproof membrane.

1.4 QUALITY ASSURANCE

- A. Perform work in accordance with NRCA Roofing and Waterproofing Manual.
- B. Installer Qualifications: Company specializing in performing the work of this section:
 - 1. With minimum five (5) years documented experience.
 - 2. Approved by membrane manufacturer.
- C. Single Source Responsibility: Provide and install products from single source.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact.
- B. Store products in weather protected environment, clear of ground and moisture.

1.6 FIELD CONDITIONS

- A. Do not apply roofing membrane during unsuitable weather.
- B. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- C. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.



1.7 WARRANTY

- A. Material Warranty: Provide membrane manufacturer's warranty agreeing to replace material that shows manufacturing defects within 30 years after installation.
- B. System Warranty: Provide manufacturer's system warranty agreeing to repair or replace roofing that leaks or is damaged due to wind or other natural causes.
 - 1. Warranty Term: 30 years.
 - 2. For repair and replacement include costs of both material and labor in warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Sika Sarnafil: www.sikacorp.com

2.2 ROOFING APPLICATIONS

- A. PVC Membrane Roofing: One ply membrane, mechanically fastened.
- B. Roofing Assembly Performance Requirements and Design Criteria:
 - 1. Roof Covering External Fire Resistance Classification: Class A when tested per UL 790.

2.3 ROOFING MEMBRANE AND ASSOCIATED MATERIALS

- A. Base Sheet: Manufacturer's standard, non-asphaltic, resin-bound, fiberglass-reinforced mat with mineral-filled fire-resistant coating.
- B. Membrane:
 - 1. Material: Polyvinyl chloride (PVC) complying with ASTM D4434/D4434M.
 - 2. Reinforcing: Internal fabric.
 - 3. Thickness: 80 mils (0.050 inch), minimum.
 - 4. Sheet Width: Factory fabricated into largest sheets possible.
 - 5. Color: To be selected by Architect from manufacturer's full color range.
- C. Seaming Materials: As recommended by membrane manufacturer.
- D. Membrane Fasteners: As recommended and approved by membrane manufacturer.
- E. Flexible Flashing Material: Same material as membrane.
- F. Base Flashing: Provide waterproof, fully adhered base flashing system at all penetrations, plane transitions, and terminations.

2.4 DECK SHEATHING AND COVER BOARDS

- A. Deck Sheathing and Cover Board: Glass mat faced gypsum panels, ASTM C1177/C1177M, fire resistant type, 1/4 inch thick.

2.5 ACCESSORIES

- A. Prefabricated Decorative Battens (over studio roofs): 2 x 2 at 75 inches on center. Hold 12 inches short from eaves.
- B. Prefabricated Flashing Accessories:
 - 1. Corners and Seams: Same material as membrane, in manufacturer's standard thicknesses.
 - 2. Penetrations: Same material as membrane, with manufacturer's standard cut-outs, rigid inserts, clamping rings, and flanges.
 - 3. Walkway Rolls: Sure-Flex Heat Weldable Walkway Rolls; 80 mils (0.080 inch) thick; gray membrane.
 - 4. Contour Rib Profile: Manufacturer's standard extruded PVC; 1-1/4 inch tall, 2-1/8 inch wide, 3/8 inch profile.
 - 5. Miscellaneous Flashing: Non-reinforced PVC membrane; 80 mils (0.080 inch) thick, in manufacturer's standard lengths and widths.
- C. Membrane Adhesive: As recommended by membrane manufacturer.



- D. Surface Conditioner for Adhesives: Compatible with membrane and adhesives.
- E. Sealants: As recommended by membrane manufacturer.
- F. Cleaner: Manufacturer's standard, clear, solvent-based cleaner.
- G. Edgings and Terminations: Manufacturer's standard edge and termination accessories.
 - 1. PVC Coated Sheet Metal.
 - 2. Termination Bar.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Per Manufacturer's Requirements.

3.2 PREPARATION

- A. Per Manufacturer's Requirements.

3.3 INSTALLATION

- A. Per Manufacturer's Requirements.

END OF SECTION 07 54 19

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fabricated sheet metal items, including flashings, counter flashings, gutters, downspouts, sheet metal roofing, exterior penetrations, and other items indicated in Schedule.
- B. Sealants for joints within sheet metal fabrications.
- C. Reglets and accessories.

1.2 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix) 2020.
- B. ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.
- C. CDA A4050 - Copper in Architecture - Handbook current edition.
- D. SMACNA (ASMM) - Architectural Sheet Metal Manual 2012.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

1.4 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.
- B. Fabricator and Installer Qualifications: Company specializing in sheet metal work with [] years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- C. Prevent contact with materials that could cause discoloration or staining.

PART 2 - PRODUCTS

2.1 SHEET MATERIALS

- A. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24 gauge, 0.0239 inch (0.61 mm) thick base metal.
- B. Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24 gauge, 0.0239 inch (0.61 mm) thick base metal, shop pre-coated with silicone modified polyester coating.
 - 1. Polyvinylidene Fluoride (PVDF) Coating: Superior performing organic powder coating, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system.
 - 2. Color: As selected by Architect from manufacturer's standard colors.

2.2 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Form pieces in longest possible lengths.
- C. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.

- D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- E. Fabricate flashings to allow toe to extend 2 inches (50 mm) over roofing gravel. Return and brake edges.

2.3 GUTTER AND DOWNSPOUT FABRICATION

- A. Gutters: SMACNA (ASMM) Rectangular profile.
- B. Downspouts: Round profile.
- C. Gutters and Downspouts: Size for rainfall intensity determined by a storm occurrence of 1 in 10 years in accordance with SMACNA (ASMM).
- D. Accessories: Profiled to suit gutters and downspouts.
 - 1. Anchorage Devices: In accordance with SMACNA (ASMM) requirements.
- E. Seal metal joints.

2.4 ACCESSORIES

- A. Fasteners: Galvanized steel, with soft neoprene washers.
- B. Underlayment: Polyethylene, 6 mil (0.15 mm) thick.
- C. Slip Sheet: Rosin sized building paper.
- D. Primer: Zinc chromate type.
- E. Protective Backing Paint: Zinc molybdate alkyd.
- F. Concealed Sealants: Non-curing butyl sealant.
- G. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
- H. Plastic Cement: ASTM D4586/D4586M, Type I.
- I. Reglets: Surface mounted type, galvanized steel; face and ends covered with plastic tape.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.2 PREPARATION

- A. Install starter and edge strips, and cleats before starting installation.
- B. Install surface mounted reglets true to lines and levels, and seal top of reglets with sealant.
- C. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil (0.4 mm).

3.3 INSTALLATION

- A. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted..
- B. Apply plastic cement compound between metal flashings and felt flashings.
- C. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- D. Secure gutters and downspouts in place with concealed fasteners.

END OF SECTION 07 62 00



**SECTION 07 84 00
FIRESTOPPING**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Firestopping systems.
- B. Firestopping of joints and penetrations in fire-resistance-rated and smoke-resistant assemblies, whether indicated on drawings or not.

1.2 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials 2020.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).
- C. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus 2020.
- D. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies 2013 (Reapproved 2017).
- E. ITS (DIR) - Directory of Listed Products current edition.
- F. FM (AG) - FM Approval Guide current edition.
- G. UL 1479 - Standard for Fire Tests of Penetration Firestops Current Edition, Including All Revisions.
- H. UL (FRD) - Fire Resistance Directory Current Edition.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
- C. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- D. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.

1.4 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
- B. Installer Qualifications: Company specializing in performing the work of this section and:
 - 1. Verification of minimum three years documented experience installing work of this type.
 - 2. Verification of at least five satisfactorily completed projects of comparable size and type.

1.5 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Firestopping Manufacturers:
 - 1. 3M Fire Protection Products: www.3m.com/firestop.

2. A/D Fire Protection Systems Inc: www.adfire.com.
3. Hilti, Inc: www.us.hilti.com.
4. Nelson FireStop Products: www.nelsonfirestop.com.
5. Specified Technologies Inc: www.stifirestop.com.
6. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 MATERIALS

- A. Firestopping Materials: Any materials meeting requirements.
- B. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.
- C. Fire Ratings: Refer to drawings for required systems and ratings.

2.3 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. Perimeter Fire Containment Firestopping: Use system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of floor assembly.
- B. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
- C. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

2.4 FIRESTOPPING FOR FLOOR-TO-FLOOR, FLOOR-TO-WALL, HEAD-OF-WALL, AND WALL-TO-WALL JOINTS

- A. Gypsum Board Walls:
 1. Wall-to-Wall Joints That Have Not Been Tested For Movement Capabilities (Static-S):
 - a. 1 Hour Construction: UL System WW-S-0063; Specified Technologies Inc. SpeedFlex TTG Track Top Gasket.

2.5 FIRESTOPPING PENETRATIONS THROUGH GYPSUM BOARD WALLS

- A. Penetrations By:
 1. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - a. 1 Hour Construction: UL System W-L-1054; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 2. Insulated Pipes:
 - a. 1 Hour Construction: UL System W-L-5029; Hilti FS-ONE Intumescent Firestop Sealant.
 3. HVAC Ducts, Insulated:
 - a. 1 Hour Construction: UL System W-L-7156; Hilti FS-ONE MAX Intumescent Firestop Sealant.

2.6 FIRESTOPPING SYSTEMS

- A. Firestopping: Any material meeting requirements.
 1. Fire Ratings: Use system that is listed by FM (AG), ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814, ASTM E119, or UL 1479 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.



- B. Remove incompatible materials that could adversely affect bond.

3.3 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

3.4 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.5 PROTECTION

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 07 84 00

**SECTION 07 92 00
JOINT SEALANTS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Nonsag gunnable joint sealants.
- B. Self-leveling pourable joint sealants.
- C. Joint backings and accessories.

1.2 REFERENCE STANDARDS

- A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer 2015 (Reapproved 2022).
- B. ASTM C794 - Standard Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants 2018.
- C. ASTM C834 - Standard Specification for Latex Sealants 2017.
- D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.
- E. ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems 2016.
- F. ASTM C1193 - Standard Guide for Use of Joint Sealants 2016.
- G. ASTM C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints 2019 (Reapproved 2020).
- H. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness 2015 (Reapproved 2021).

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data for Sealants: Submit manufacturer's technical data sheets for each product to be used, that includes the following.
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 - 4. Substrates the product should not be used on.
 - 5. Substrates for which use of primer is required.
 - 6. Substrates for which laboratory adhesion and/or compatibility testing is required.
 - 7. Installation instructions, including precautions, limitations, and recommended backing materials and tools.
- C. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
- D. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.
- E. Preconstruction Laboratory Test Reports: Submit at least four weeks prior to start of installation.
- F. Field Quality Control Plan: Submit at least two weeks prior to start of installation.
- G. Field Quality Control Log: Submit filled out log for each length or instance of sealant installed, within 10 days after completion of inspections/tests; include bagged test samples and photographic records, if any.

1.4 QUALITY ASSURANCE

- A. Maintain one copy of each referenced document covering installation requirements on site.



- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and with at least three years of documented experience.
- D. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.
- E. Preconstruction Laboratory Testing: Arrange for sealant manufacturer(s) to test each combination of sealant, substrate, backing, and accessories.
 - 1. Adhesion Testing: In accordance with ASTM C794.
 - 2. Compatibility Testing: In accordance with ASTM C1087.
 - 3. Allow sufficient time for testing to avoid delaying the work.
 - 4. Deliver to manufacturer sufficient samples for testing.
 - 5. Report manufacturer's recommended corrective measures, if any, including primers or techniques not indicated in product data submittals.
 - 6. Testing is not required if sealant manufacturer provides data showing previous testing, not older than 24 months, that shows satisfactory adhesion, lack of staining, and compatibility.
- F. Field Quality Control Plan:
 - 1. Visual inspection of entire length of sealant joints.
 - 2. Non-destructive field adhesion testing of sealant joints, except interior acrylic latex sealants.
 - 3. Field testing agency's qualifications.
 - 4. Field Quality Control Log Form: Show same data fields as on Preinstallation Field Adhesion Test Log, with known information filled out and lines for multiple tests per sealant/substrate combinations; include visual inspection and specified field testing; allow for possibility that more tests than minimum specified may be necessary.
- G. Field Adhesion Test Procedures:
 - 1. Allow sealants to fully cure as recommended by manufacturer before testing.
 - 2. Have a copy of the test method document available during tests.
 - 3. Record the type of failure that occurred, other information required by test method, and the information required on the Field Quality Control Log.
 - 4. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Architect.
- H. Non-Destructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Nondestructive Spot Method.

1.5 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Correct defective work within a five year period after Date of Substantial Completion.
- C. Warranty: Include coverage for installed sealants and accessories that fail to achieve watertight seal , exhibit loss of adhesion or cohesion, or do not cure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Non-Sag Sealants: Permits application in joints on vertical surfaces without sagging or slumping.
 - 1. Bostik Inc: www.bostik-us.com.
 - 2. Dow: www.dow.com.
 - 3. Sika Corporation: www.usa.sika.com.
 - 4. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Self-Leveling Sealants: Pourable or self-leveling sealant that has sufficient flow to form a smooth, level surface when applied in a horizontal joint.

1. Bostik Inc: www.bostik-us.com.
2. Dow: www.dow.com.
3. Sika Corporation: www.usa.sika.com.
4. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com.
5. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 JOINT SEALANT APPLICATIONS

A. Scope:

1. Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to, the following items.
 - a. Wall expansion and control joints.
 - b. Joints between door, window, and other frames and adjacent construction.
 - c. Joints between different exposed materials.
 - d. Openings below ledge angles in masonry.
 - e. Other joints indicated below.
2. Do not seal the following types of joints.
 - f. Intentional weepholes in masonry.
 - g. Joints indicated to be treated with manufactured expansion joint cover or some other type of sealing device.
 - h. Joints where sealant is specified to be provided by manufacturer of product to be sealed.
 - i. Joints where installation of sealant is specified in another section.
 - j. Joints between suspended panel ceilings/grid and walls.

B. Exterior Joints: Use non-sag non-staining silicone sealant, unless otherwise indicated.

1. Control and Expansion Joints in Concrete Paving: Self-leveling polyurethane "traffic-grade" sealant.

C. Interior Joints: Use non-sag polyurethane sealant, unless otherwise indicated.

1. Wall and Ceiling Joints in Non-Wet Areas: Acrylic emulsion latex sealant.
2. Wall and Ceiling Joints in Wet Areas: Non-sag polyurethane sealant for continuous liquid immersion.
3. Joints between Fixtures in Wet Areas and Floors, Walls, and Ceilings: Mildew-resistant silicone sealant; white.
4. Narrow Control Joints in Interior Concrete Slabs: Self-leveling epoxy sealant.
5. Other Floor Joints: Self-leveling polyurethane "traffic-grade" sealant.

D. Interior Wet Areas: Bathrooms and restrooms; fixtures in wet areas include plumbing fixtures, countertops, cabinets, and other similar items.

E. Sound-Rated Assemblies: Walls and ceilings identified as "STC-rated", "sound-rated", or "acoustical".

2.3 JOINT SEALANTS - GENERAL

A. Colors: As indicated on drawings.

2.4 NONSAG JOINT SEALANTS

A. Non-Staining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.

1. Movement Capability: Plus and minus 50 percent, minimum.
2. Non-Staining To Porous Stone: Non-staining to light-colored natural stone when tested in accordance with ASTM C1248.
3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
4. Color: Match adjacent finished surfaces.
5. Cure Type: Single-component, neutral moisture curing.

B. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.

1. Color: White.
- C. Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.
 1. Movement Capability: Plus and minus [] percent, minimum.
- D. Polyurethane Sealant for Continuous Water Immersion: ASTM C920, Grade NS, Uses M and A; single or multi-component; explicitly approved by manufacturer for continuous water immersion; suitable for traffic exposure when recessed below traffic surface.
 1. Movement Capability: Plus and minus 35 percent, minimum.
- E. Acrylic Emulsion Latex: Water-based; ASTM C834, single component, non-staining, non-bleeding, non-sagging; not intended for exterior use.
 1. Color: To be selected by Architect from manufacturer's standard range.

2.5 SELF-LEVELING SEALANTS

- A. Self-Leveling Polyurethane Sealant: ASTM C920, Grade P, Uses M and A; single or multi-component; explicitly approved by manufacturer for traffic exposure; not expected to withstand continuous water immersion .
 1. Movement Capability: Plus and minus 25 percent, minimum.
 2. Hardness Range: 35 to 55, Shore A, when tested in accordance with ASTM C661.
 3. Color: To be selected by Architect from manufacturer's standard range.
- B. Self-Leveling Polyurethane Sealant for Continuous Water Immersion: Polyurethane; ASTM C920, Grade P, Uses M and A; single component; explicitly approved by manufacturer for traffic exposure and continuous water immersion.
 1. Movement Capability: Plus and minus 25 percent, minimum.
 2. Hardness Range: 35 to 55, Shore A, when tested in accordance with ASTM C661.
 3. Color: To be selected by Architect from manufacturer's standard range.
- C. Semi-Rigid Self-Leveling Epoxy Joint Filler: Epoxy or epoxy/polyurethane copolymer; intended for filling cracks and control joints not subject to significant movement; rigid enough to support concrete edges under traffic.
 1. Composition: Multi-component, 100 percent solids by weight.
 2. Durometer Hardness: Minimum of 85 for Type A or 35 for Type D, after seven days when tested in accordance with ASTM D2240.
 3. Color: To be selected by Architect from manufacturer's standard colors.
 4. Joint Width, Minimum: 1/8 inch (3 mm).

2.6 ACCESSORIES

- A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specific sealant used, and recommended by backing and sealant manufacturers for specific application.
- B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- C. Masking Tape: Self-adhesive, nonabsorbent, non-staining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.
- C. Verify that backer rods are of the correct size.

3.2 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.



- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.3 INSTALLATION

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform installation in accordance with ASTM C1193.
- C. Install bond breaker backing tape where backer rod cannot be used.
- D. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- E. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- F. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.
- G. Concrete Floor Joint Filler: After full cure, shave joint filler flush with top of concrete slab.

3.4 FIELD QUALITY CONTROL

- A. Perform field quality control inspection/testing as specified in PART 1 under QUALITY ASSURANCE article.
- B. Non-Destructive Adhesion Testing: If there are any failures in first 100 linear feet (30 linear m), notify Architect immediately.
- C. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

END OF SECTION 07 92 00

**SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Non-fire-rated hollow metal doors and frames.
- B. Hollow metal frames for wood doors.
- C. Thermally insulated hollow metal doors with frames.
- D. Sound-rated hollow metal doors and frames.
- E. Hollow metal borrowed lites glazing frames.

1.2 ABBREVIATIONS AND ACRONYMS

- A. ANSI: American National Standards Institute.
- B. HMMA: Hollow Metal Manufacturers Association.
- C. NAAMM: National Association of Architectural Metal Manufacturers.
- D. SDI: Steel Door Institute.
- E. UL: Underwriters Laboratories.

1.3 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- B. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors 2018.
- C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100) 2017.
- D. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames 2020.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- F. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable 2021a.
- G. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength 2018a.
- H. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete 2020.
- I. ASTM C476 - Standard Specification for Grout for Masonry 2020.
- J. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements 2009 (Reapproved 2016).
- K. ASTM E413 - Classification for Rating Sound Insulation 2016.
- L. BHMA A156.115 - Hardware Preparation In Steel Doors And Steel Frames 2016.
- M. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.
- N. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames 2002.
- O. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames 2011.
- P. NAAMM HMMA 840 - Guide Specifications For Receipt, Storage and Installation of Hollow Metal Doors and Frames 2007.
- Q. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames 2014.

- R. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames 2013.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.
- D. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.
- B. Maintain at project site copies of reference standards relating to installation of products specified.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 - PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Hollow Metal Doors and Frames:
 - 1. Ceco Door, an Assa Abloy Group company: www.assaabloydss.com.
 - 2. Republic Doors, an Allegion brand: www.republicdoor.com.
 - 3. Steelcraft, an Allegion brand: www.allegion.com.
 - 4. Technical Glass Products; SteelBuilt Window & Door Systems: www.tgpamerica.com.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Sound-Rated Hollow Metal Doors and Frames:
 - 1. AMBICO Limited: www.ambico.com.
 - 2. Megamet Industries, Inc; MegaSonic 2A-B - Series Flush Doors: www.megametusa.com.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 PERFORMANCE REQUIREMENTS

- A. Requirements for Hollow Metal Doors and Frames:
 - 1. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
 - 2. Accessibility: Comply with ICC A117.1 and ADA Standards.
 - 3. Exterior Door Top Closures: Flush end closure channel, with top and door faces aligned.
 - 4. Door Edge Profile: Manufacturers standard for application indicated.
 - 5. Typical Door Face Sheets: Flush.
 - 6. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturers standard.
 - 7. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
 - 8. Zinc Coating for Typical Interior and/or Exterior Locations: Provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvanized) by the hot-dip process in accordance



with ASTM A653/A653M, with manufacturer's standard coating thickness, unless noted otherwise for specific hollow metal doors and frames.

- a. Based on SDI Standards: Provide at least A40/ZF120 (galvannealed) when necessary, coating not required for typical interior door applications, and at least A60/ZF180 (galvannealed) for corrosive locations.
- B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.3 HOLLOW METAL DOORS

- A. Door Finish: Factory primed and field finished.
- B. Exterior Doors: Thermally insulated.
 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 3 - Extra Heavy-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 16 gauge, 0.053 inch (1.3 mm), minimum.
 - e. Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.
 2. Door Thickness: 1-3/4 inches (44.5 mm), nominal.
 3. Weatherstripping: Refer to Section 08 71 00.
- C. Interior Doors, Non-Fire-Rated:
 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 2 - Heavy-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 18 gauge, 0.042 inch (1.0 mm), minimum.
 2. Door Thickness: 1-3/4 inches (44.5 mm), nominal.
- D. Sound-Rated Interior Doors:
 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 2 - Heavy-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 18 gauge, 0.042 inch (1.0 mm), minimum.
 2. Sound Transmission Class (STC) Rating of Door and Frame Assembly: STC of 39, minimum, calculated in accordance with ASTM E413, and tested in accordance with ASTM E90.
 3. Door Core Material: Manufacturer's standard construction as required to meet acoustic requirements indicated.
 4. Door Thickness: As required to meet acoustic requirements indicated.
 5. Sound Seals: Integral, in door and/or frame.
 6. Opening Force of Sound-Rated Doors, Non-Fire-Rated: 5 pounds (22.2 N), maximum, in compliance with ADA Standards.

2.4 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. Exterior Door Frames: Knock-down type.
 1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
 2. Frame Metal Thickness: 14 gauge, 0.067 inch (1.7 mm), minimum.
 3. Weatherstripping: Separate, see Section 08 71 00.

- C. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
 - 1. Terminated Stops: Provide at interior doors; closed end stop terminated 6 inch (150 mm), maximum, above floor at 45 degree angle.
 - 2. Frame Metal Thickness: 16 gauge, 0.053 inch (1.3 mm), minimum.
 - 3. Frame Finish: Factory primed and field finished.
- D. Sound-Rated Door Frames: Knock-down type.
 - 1. Frame Metal Thickness: 16 gauge, 0.053 inch (1.3 mm), minimum.
 - 2. Frame Finish: Factory primed and field finished.
- E. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.
- F. Borrowed Lites Glazing Frames: Construction and face dimensions to match door frames, and as indicated on drawings.
- G. Frames Wider than 48 inches (1219 mm): Reinforce with steel channel fitted tightly into frame head, flush with top.

2.5 FINISHES

- A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.
- B. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15 mil, 0.015 inch (0.4 mm) dry film thickness (DFT) per coat; provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.6 ACCESSORIES

- A. Louvers: Roll formed steel with overlapping frame; finish same as door components ; factory-installed.
- B. Glazing: As specified in Section 08 80 00, factory installed.
- C. Grout for Frames: Mortar grout complying with ASTM C476 with maximum slump of 4 inches (102 mm) as measured in accordance with ASTM C143/C143M for hand troweling in place; plaster grout and thinner pumpable grout are prohibited.
- D. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
- E. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify that finished walls are in plane to ensure proper door alignment.

3.2 PREPARATION

- A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

3.3 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B. Coordinate frame anchor placement with wall construction.
- C. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
- D. Install door hardware as specified in Section 08 71 00.
- E. Coordinate installation of electrical connections to electrical hardware items.



3.4 TOLERANCES

- A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.
- B. Maximum Diagonal Distortion: 1/16 inch (1.6 mm) measured with straight edge, corner to corner.

3.5 ADJUSTING

- A. Adjust for smooth and balanced door movement.
- B. Adjust sound control doors so that seals are fully engaged when door is closed.
- C. Test sound control doors for force to close, latch, and unlatch; adjust as necessary in compliance with requirements.

END OF SECTION 08 11 13



**SECTION 08 11 16
ALUMINUM DOORS AND FRAMES**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Flush aluminum doors with aluminum face sheets.
- B. Glazed aluminum doors.
- C. Aluminum frames.
- D. Flush door panels.
- E. Glazing.

1.2 REFERENCE STANDARDS

- A. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document) 2015.
- B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum 2014 (2015 Errata).
- C. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- E. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2021.
- F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
- G. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.
- H. ASTM C365/C365M - Standard Test Method for Flatwise Compressive Properties of Sandwich Cores 2016.
- I. ASTM C1363 - Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus 2019.
- J. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's descriptive literature for each type of door; include information on fabrication methods.
- C. Manufacturer's qualification statement.
- D. Installer's qualification statement.
- E. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with not less than five years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver aluminum components in manufacturer's standard protective packaging, palletted, crated, or banded together.
- B. Inspect delivered components for damage and replace. Repaired components will not be accepted.

- C. Store components in clean, dry, indoor area, under cover in manufacturer's packaging until installation.
- D. Protect materials and finish from damage during handling and installation.

1.6 FIELD CONDITIONS

- A. Do not begin installation of interior aluminum components until space has been enclosed and ambient thermal conditions are being maintained at levels consistent with final project requirements.

1.7 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide ten year manufacturer warranty for defects in workmanship and materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Flush Aluminum Doors with Aluminum Face Sheets:
 - 1. Basis of Design: [Kawneer 19350 Series](#).
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 DOORS AND FRAMES

- A. Accessibility: Comply with ICC A117.1 and ADA Standards.
- B. Flush Aluminum Doors with Aluminum Face Sheets: Aluminum internal framing and faces; no steel components.
 - 1. Thickness: 1-3/4 inches (44 mm), nominal.
 - 2. Finish: Class I - Natural anodized.
- C. Aluminum Frames for Doors, Sidelights, or Transoms: Extruded aluminum, non-thermally broken hollow or C-shaped sections; no steel components.
 - 1. Frame Depth: To fit wall thicknesses as indicated on drawings.
 - 2. Finish: Same as doors.
 - 3. Weatherstripping: Replaceable pile type; at jambs and head.
 - 4. Sidelight/Transom Glazing: Sealed insulating glass units, 1 inch (25 mm) overall thickness, with two panes of clear 1/4 inch (6 mm) thick fully tempered glass.
- D. Dimensions and Shapes: As indicated on drawings; dimensions indicated are nominal.
 - 1. Provide the following clearances:
 - a. Hinge and Lock Stiles: 1/8 inch (3.2 mm).
 - b. Between Meeting Stiles: 1/4 inch (6.4 mm).
 - c. At Top Rail and Bottom Rail: 1/8 inch (3.2 mm).

2.3 COMPONENTS

- A. Flush Door Panels: Without visible seams on face sheet.
 - 1. Framing and Hardware Backup: Extruded aluminum tubing, 1/8 inch (3.2 mm) minimum thickness.
 - 2. Perimeter Edges: Extruded aluminum cap.
 - 3. Exterior Doors Thermal Transmittance: U-value of 0.50, nominal, when tested in accordance with ASTM C1363.
 - 4. Core: Rigid honeycomb core of marine grade organic material coated with phenolic resin, minimum compression strength of 94.8 psi (4.53 kPa), when tested in accordance with ASTM C365/C365M.
 - 5. Laminating Adhesive: Manufacturer's standard low-VOC materials.
- B. Frames: Extruded aluminum shapes, not less than 0.062 inch (1.6 mm) thick, reinforced at hinge and strike locations.
 - 1. Corner Brackets: Extruded aluminum, fastened with stainless steel screws.

2. Trim: Extruded aluminum, not less than 0.062 inch (1.6 mm) thick, removable snap-in type without exposed fasteners.

2.4 MATERIALS

- A. Aluminum Sheet: ASTM B209/B209M, alloy 5005, temper H14, stretcher leveled.
- B. Extruded Aluminum: ASTM B221 (ASTM B221M), alloy 6063, temper T5, or alloy 6463, temper T5.

2.5 FINISHES

- A. Class I Natural Anodized Finish: Clear anodic coating; AAMA 611 AA-M12C22A41, minimum dry film thickness (DFT) of 0.7 mils, 0.0007 inch (0.018 mm).

2.6 ACCESSORIES

- A. Fasteners: Aluminum, non-magnetic stainless steel, or other material warranted by manufacturer as non-corrosive and compatible with aluminum components.
- B. Brackets and Reinforcements: Manufacturer's high-strength aluminum units where feasible, otherwise, non-magnetic stainless steel or steel hot-dip galvanized in compliance with ASTM A123/A123M.
- C. Bituminous Coating: Cold-applied asphaltic mastic, compounded for 30-mil (0.76 mm) thickness per coat.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that wall surfaces and openings are ready to receive frames and are within tolerances specified in manufacturer's instructions.
- B. Verify that frames installed by other trades for installation of doors of this section are in strict accordance with recommendations and approved shop drawings and within tolerances specified in manufacturer's instructions.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Perform cutting, fitting, forming, drilling, and grinding of frames as required for project conditions.
- B. Replace components with damage to exposed finishes.
- C. Separate dissimilar metals to prevent electrolytic action between metals.

3.3 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and approved shop drawings.
- B. Set frames plumb, square, level, and aligned to receive doors. Anchor frames to adjacent construction in strict accordance with manufacturer's recommendations and within specified tolerances.
- C. Where aluminum surfaces contact metals other than stainless steel, zinc, or small areas of white bronze, protect from direct contact by painting dissimilar metal with heavy coating of bituminous paint.
- D. Hang doors and adjust hardware to achieve specified clearances and proper door operation.

3.4 CLEANING

- A. Upon completion of installation, thoroughly clean door and frame surfaces in accordance with AAMA 609 & 610.
- B. Do not use abrasive, caustic, or acid cleaning agents.

3.5 PROTECTION

- A. Protect products of this section from damage caused by subsequent construction until Date of Substantial Completion.



- B. Replace damaged or defective components that cannot be repaired to a condition indistinguishable from undamaged components.

END OF SECTION 08 1116

**SECTION 08 14 16
FLUSH WOOD DOORS**

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- A. Section 08 11 13 - Hollow Metal Doors and Frames.
- B. Section 08 80 00 - Glazing.
- C. Section 09 93 00 - Staining and Transparent Finishing: Field finishing of doors.

1.2 REFERENCE STANDARDS

- A. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass 2018.
- B. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition 2014, with Errata (2016).
- C. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards, U.S. Version 4.0 2021, with Errata.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- C. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
- D. Samples: Submit two samples of door veneer, 4 by 4 inch in size illustrating wood grain, stain color, and sheen.
- E. Manufacturer's Installation Instructions: Indicate special installation instructions.
- F. Specimen warranty.
- G. Warranty, executed in Owner's name.

1.4 QUALITY ASSURANCE

- A. Maintain one copy of the specified door quality standard on site for review during installation and finishing.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section, with not less than three years of documented experience.
 - 1. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.
- C. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.
- D. Quality Certification:
 - 1. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 2. Provide designated labels on shop drawings as required by certification program.
 - 3. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.
 - 4. Arrange and pay for inspections required for certification.
 - 5. Replace, repair, or rework all work for which certification is refused.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Package, deliver and store doors in accordance with specified quality standard.
- B. Accept doors on site in manufacturer's packaging, and inspect for damage.

- C. Protect doors with resilient packaging sealed with heat shrunk plastic; do not store in damp or wet areas or areas where sunlight might bleach veneer; seal top and bottom edges with tinted sealer if stored more than one week, and break seal on site to permit ventilation.

1.6 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Interior Doors: Provide manufacturer's warranty for the life of the installation.
- C. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Wood Veneer Faced Doors:
 - 1. Haley Brothers: www.haleybros.com.
 - 2. Oregon Door; Architectural Series: www.oregondoor.com.
 - 3. VT Industries, Inc: www.vtindustries.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. High Pressure Decorative Laminate (HPDL) Faced Doors:
 - 1. Oregon Door; Architectural Series: www.oregondoor.com.
 - 2. Masonite Architectural; Aspiro Choice Laminate Doors: www.architectural.masonite.com.
 - 3. VT Industries, Inc: www.vtindustries.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 DOORS AND PANELS

- A. Doors: See drawings for locations and additional requirements.
 - 1. Quality Standard: Custom Grade, Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
 - 2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.
 - 3. High Pressure Decorative Laminate (HPDL) Faced Doors: 5-ply unless otherwise indicated.
- B. Interior Doors: 1-3/4 inches (44 mm) thick unless otherwise indicated; flush construction.
 - 1. Provide solid core doors at each location.
 - 2. Wood veneer facing with factory transparent finish as indicated on drawings.
 - 3. High pressure decorative laminate (HPDL) finish as indicated on drawings.

2.3 DOOR AND PANEL CORES

- A. Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated.

2.4 DOOR FACINGS

- A. Veneer Facing for Transparent Finish:
 - 1. Grade: Premium, with Grade A faces
 - 2. Species: Maple
 - 3. Cut: Quarter sliced.
 - 4. Match between Veneer Leaves: Book match.
 - 5. Assembly of Veneer Leaves on Door Faces: Center-balance match.
 - 6. Pair and Set Match: Provide for doors hung in same opening.
 - 7. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.
 - 8. Transom Match: Continuous match.
 - 9. Exposed Vertical Edges: Same species as faces.
 - 10. Core: Glued wood stave.

11. Construction: Five or seven plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Faces are bonded to core using a hot press.
12. WDMA I.S.1-A Performance Grade: Heavy Duty.

2.5 DOOR CONSTRUCTION

- A. Fabricate doors in accordance with door quality standard specified.
- B. Cores Constructed with stiles and rails:
- C. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- D. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
- E. Provide edge clearances in accordance with the quality standard specified.

2.6 FINISHES - WOOD VENEER DOORS

- A. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
 1. Transparent:
 - a. System - 1, Lacquer, Nitrocellulose.
 - b. Sheen: Flat.

2.7 ACCESSORIES

- A. Hollow Metal Door Frames: See Section 08 11 13.
- B. Metal Louvers: See Section 08 11 13.
- C. Glazed Openings:
 1. Heat-Strengthened and Fully Tempered Glass: ASTM C1048.
 2. Tint: Clear.
- D. Glazing Stops: Rolled steel channel shape, butted corners; prepared for countersink style tamper proof screws.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.2 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and specified quality standard.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Use machine tools to cut or drill for hardware.
- D. Coordinate installation of doors with installation of frames and hardware.
- E. Coordinate installation of glazing.

3.3 TOLERANCES

- A. Comply with specified quality standard for fit and clearance tolerances.
- B. Comply with specified quality standard for telegraphing, warp, and squareness.

3.4 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.
- B. Adjust closers for full closure.

END OF SECTION 08 14 16

**SECTION 08 31 00
ACCESS DOORS AND PANELS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Wall mounted access units.
- B. Ceiling mounted access units.

1.2 REFERENCE STANDARDS

- A. Not Applicable

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.
- C. Manufacturer's Installation Instructions: Indicate installation requirements.
- D. Manufacturer's Qualification Statement.
- E. Installer's Qualification Statement.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND PANELS ASSEMBLIES

- A. Wall-Mounted Units:
 - 1. Size: As required.
 - 2. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
 - 3. Gypsum Board Mounting Criteria: Provide drywall bead frame with door surface flush with wall surface.
- B. Wall-Mounted Units in Wet Areas:
 - 1. Panel Material: Steel, hot-dipped zinc, or zinc-aluminum-alloy coated.
 - 2. Size: As required.
 - 3. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
 - 4. Gypsum Board Mounting Criteria: Provide drywall bead frame with door surface flush with wall surface.
- C. Fire-Rated Wall-Mounted Units:
 - 1. Wall Fire-Rating: As indicated on drawings.
 - 2. Panel Material: Steel.
 - 3. Size: As required.
 - 4. Door/Panel: Insulated double-surface panel, with tool-operated spring or cam lock and no handle.
- D. Ceiling-Mounted Units:
 - 1. Panel Material: Steel, hot-dipped zinc, or zinc-aluminum-alloy coated.
 - 2. Size - Lay-In Grid Ceilings: To match module of ceiling grid.
 - 3. Size - Other Ceilings: As required.
 - 4. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
- E. Fire-Rated Ceiling-Mounted Units:
 - 1. Ceiling Fire-Rating: As indicated on drawings.

2. Panel Material: Steel, hot-dipped zinc, or zinc-aluminum-alloy coated.
3. Size: 12 by 12 inches (305 by 305 mm).
4. Size: As required.

2.2 WALL AND CEILING MOUNTED ACCESS UNITS

- A. Provide wall or ceiling access doors of size and type required to access all concealed items needing access / service.
- B. Manufacturers:
 1. ACUDOR Products Inc: www.acudor.com.
 2. Karp Associates, Inc: www.karpinc.com.
 3. Milcor, Inc: www.milcorinc.com.
 4. Substitutions: See Section 01 60 00 - Product Requirements.

- C. Wall and Ceiling Mounted Units: Factory fabricated door and frame, fully assembled units with corner joints welded, filled and ground flush; square and without rack or warp; coordinate requirements with type of installation assembly being used for each unit.
 1. Material: Steel, hot-dipped zinc or zinc-aluminum-alloy coated.
 2. Style: Exposed frame with door surface flush with frame surface.
 - a. Gypsum Board Mounting Criteria: Use drywall bead type frame.
 3. Door Style: Single thickness with rolled or turned in edges.
 4. Frames: 16 gauge, 0.0598 inch (1.52 mm), minimum thickness.
 5. Heavy Duty Frames: 14 gauge, 0.0747 inch (1.89 mm), minimum thickness.
 6. Units in Fire-Rated Assemblies: Fire rating as required by applicable code for fire-rated assembly that access doors are being installed.
 7. Steel Finish: Primed.
 8. Primed and Factory Finish: Polyester powder coat; color [_____].

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that rough openings are correctly sized and located.
- B. Begin installation only after substrates have been properly prepared, and if the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to proceeding with this work.
- B. Prepare surfaces using methods recommended by manufacturer for applicable substrates in accordance with project conditions.

3.3 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Install frames plumb and level in openings, and secure units rigidly in place.
- C. Position units to provide convenient access to concealed equipment when necessary.

END OF SECTION 08 31 00



SECTION 08 36 13
SECTIONAL DOORS

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Overhead sectional door electrically operated.
- B. Operating hardware and supports.
- C. Electrical controls.

1.2 RELATED REQUIREMENTS

- A. Section 055000 - Metal Fabrications: Steel channel opening frame.
- B. Section 061000 - Rough Carpentry: Rough wood framing for door opening.
- C. Section 079200 - Joint Sealants: Sealing joints between frames and adjacent construction.
- D. Section 087100 - Door Hardware: Lock cylinders.
- E. Section 099113 - Exterior Painting: Finish painting.
- F. Section 260533.13 - Conduit for Electrical Systems: Conduit from electric circuit to operator and from operator to control station.
- G. Section 260533.13 - Conduit for Electrical Systems: Conduit from fire alarm system.
- H. Section 260533.13 - Conduit for Electrical Systems: Empty conduit from control units to door operator.
- I. Section 260583 - Wiring Connections.
- J. Section 284600 - Fire Detection and Alarm: Fire alarm interconnection.

1.3 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc- Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- B. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004 (Reapproved 2012).
- C. DASMA 102 - American National Standard Specifications for Sectional Overhead Type Doors; 2011.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate opening dimensions and required tolerances, connection details, anchorage spacing, hardware locations, and installation details.
- C. Product Data: Show component construction, anchorage method, and hardware.
- D. Samples: Submit two panel finish samples, by inch in size, illustrating color and finish.
- E. Manufacturer's Installation Instructions: Include any special procedures required by project conditions.
- F. Maintenance Data: Include data for motor and transmission, shaft and gearing, lubrication frequency, spare part sources.



- G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years documented experience.

1.6 WARRANTY

- A. See Section 017800 - Closeout Submittals for warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: SteelForm S-20 manufactured by Raynor, which is located at: 1101 East River Rd. P. O. Box 448 ; Dixon, IL 61021-0448; Toll Free Tel: 800-4-RAYNOR; Tel: 815-288- 1431; Fax: 888-598-4790; Email: request info (thegarage@raynor.com); Web: www.raynor.com
- B. Other Acceptable Manufacturers - Sectional Doors:
 - 1. C.H.I. Overhead Doors; Model 3295 Aluminum Full-View Doors: www.chiohd.com/#sle.
 - 2. Clopay Building Products; Model 3720: www.clopaydoor.com/#sle.
 - 3. Substitutions: See Section 016000 - Product Requirements.

2.2 STEEL DOORS

- A. Steel Doors: Flush steel, insulated; standard lift operating style with track and hardware; complying with DASMA 102, Commercial application.
 - 1. Door Nominal Thickness: 2 inches thick.
 - 2. Air Leakage Rate: Less than 0.40 cfm/sf when tested in accordance with ASTM E283 at test pressure difference of 1.57 psf.
 - 3. Exterior Finish: Factory finished with acrylic baked enamel; color as selected by Architect.
 - 4. Electric Operation: motor operation.
- B. Door Panels: Steel construction; outer steel sheet of 20 gage, 0.0359 inch minimum thickness, flush profile; inner steel sheet of 20 gage, 0.0359 inch minimum thickness, flat profile; core reinforcement sheet steel roll formed to channel shape, rabbeted weather joints at meeting rails; polyurethane insulation.

2.3 COMPONENTS

- A. Track: Rolled galvanized steel, 0.090 inch minimum thickness; 2 inch wide, continuous one piece per side; galvanized steel mounting brackets 1/4 inch thick. Finish to be selected by Architect.
- B. Hinge and Roller Assemblies: Heavy duty hinges and adjustable roller holders of galvanized steel; floating hardened steel bearing rollers, located at top and bottom of each panel, each side.
- C. Lift Mechanism: Torsion spring on cross head shaft, with braided galvanized steel lifting cables.
- D. Sill Weatherstripping: Resilient hollow rubber strip, one piece; fitted to bottom of door panel, full length contact.
- E. Jamb Weatherstripping: Roll formed steel section full height of jamb, fitted with resilient weatherstripping, placed in moderate contact with door panels.
- F. Head Weatherstripping: EPDM rubber seal, one piece full length.
- G. Panel Joint Weatherstripping: Neoprene foam seal, one piece full length.



H. Lock: Inside center mounted, adjustable keeper, spring activated latch bar with feature to retain in locked or retracted position; interior and exterior handle.

I. Lock Cylinders: Keyed alike.

2.4 MATERIALS

A. Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G60/Z180 coating, plain surface.

B. Insulation: Foamed-in-place polyurethane, bonded to facing.

C. Metal Primer Paint: Zinc molybdate type.

2.5 ELECTRIC OPERATION

A. Electric Operators:

1. Product Basis-of-Design: Synergy 380 by Marantec Antriebstechnik

2. Mounting: Side mounted on cross head shaft.

3. Motor Enclosure:

4. Motor Rating: 1 hp; continuous duty.

5. Motor Voltage: 120 volts, single phase, 60 Hz.

6. Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.

7. Controller Enclosure: NEMA 250, Type 1.

8. Opening Speed: 12 inches per second.

9. Brake: Adjustable friction clutch type, activated by motor controller.

10. Manual override in case of power failure.

11. Refer to Section 260583 for electrical connections.

B. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated; enclose terminal lugs in terminal box sized to conform to NFPA 70.

C. Control Station: Provide standard three button (Open-Close-Stop) momentary-contact control device for each operator conforming to UL 325.

1. 24 volt circuit.

2. Surface mounted, at interior door jamb.

3. Entrapment Protection Devices: Provide sensing devices and safety mechanisms conforming to UL 325.

a. Primary Device: Provide electric sensing edge, wireless sensing, NEMA 1 photo eye sensors, or NEMA 4X photo eye sensors as required with momentary-contact control device.

D. Safety Edge: Located at bottom of sectional door panel, full width; electro-mechanical sensitized type, wired to stop and reverse door direction upon striking object; hollow neoprene covered to provide weatherstrip seal.

E. Provide interconnection to security system.

F. Hand Held Transmitter: Digital control, and resettable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that wall openings are ready to receive work and opening dimensions and tolerances are within specified limits.

B. Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

A. Prepare opening to permit correct installation of door unit to perimeter air and vapor barrier seal.

B. Apply primer to wood frame.



3.3 INSTALLATION

- A. Install door unit assembly in accordance with manufacturer's instructions.
- B. Anchor assembly to wall construction and building framing without distortion or stress.
- C. Securely brace door tracks suspended from structure. Secure tracks to structural members only.
- D. Fit and align door assembly including hardware.
- E. Coordinate installation of electrical service. Complete power and control wiring from disconnect to unit components.

3.4 TOLERANCES

- A. Maximum Variation from Plumb: 1/16 inch.
- B. Maximum Variation from Level: 1/16 inch.
- C. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch from 10 ft straight edge.
- D. Maintain dimensional tolerances and alignment with adjacent work.

3.5 ADJUSTING

- A. Adjust door assembly for smooth operation and full contact with weatherstripping.
- B. Have manufacturer's field representative present to confirm proper operation and identify adjustments to door assembly for specified operation.

3.6 CLEANING

- A. Clean doors and frames and glazing.
- B. Remove temporary labels and visible markings.

3.7 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.
- B. Do not permit construction traffic through overhead door openings after adjustment and cleaning.

END OF SECTION 08 36 13

SECTION 08 41 13
ALUMINUM-FRAMED STOREFRONTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Aluminum-framed storefront, with vision glass.
- B. Aluminum doors and frames.
- C. Weatherstripping.

1.2 RELATED REQUIREMENTS

- A. Section 08 71 00 - Door Hardware: Hardware items other than specified in this section.
- B. Section 08 80 00 - Glazing: Glass and glazing accessories.

1.3 REFERENCE STANDARDS

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site 2015.
- B. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document) 2015.
- C. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum 2014 (2015 Errata).
- D. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2021.
- E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
- F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.
- G. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen 2019.
- H. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference 2014 (Reapproved 2021).
- I. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic) 2019.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.
- D. Samples: Submit two samples 6 x 6 inches in size illustrating finished aluminum surface, glass, glazing materials.
- E. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
- F. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.
- G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.



1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handle products of this section in accordance with AAMA CW-10.
- B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.8 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C). Maintain this minimum temperature during and 48 hours after installation.

1.9 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- D. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Kawneer
- B. Arcadia

2.2 BASIS OF DESIGN -- FRAMING FOR INSULATING GLAZING

- A. Center-Set Style, Thermally-Broken:
 - 1. Basis of Design: [Kawneer Trifab 451 Series](#).
 - 2. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep (51 mm wide by 114 mm deep).
 - 3. Arcadia TC-470.

2.3 BASIS OF DESIGN -- SWINGING DOORS

- A. Medium Stile, Insulating Glazing, Thermally-Broken:
 - 1. Basis of Design: [Kawneer 19350 Series](#).
 - 2. Thickness: 1-3/4 inches (43 mm).

2.4 ALUMINUM-FRAMED STOREFRONT

- A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Finish: Class II natural anodized.
 - a. Factory finish all surfaces that will be exposed in completed assemblies.
 - b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
 - 2. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 - 3. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.



4. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
 5. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F (95 degrees C) over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
 6. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
 7. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
- B. Performance Requirements
1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
 - a. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
 2. Air Leakage: 0.06 cfm/sq ft (0.3 L/sec sq m) maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf (75 Pa) pressure difference.

2.5 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
1. Glazing Stops: Flush.
- B. Glazing: See Section 08 80 00.
- C. Swing Doors: Glazed aluminum.
1. Thickness: 1-3/4 inches (43 mm).
 2. Top Rail: 4 inches (100 mm) wide.
 3. Vertical Stiles: 4-1/2 inches (115 mm) wide.
 4. Bottom Rail: 10 inches (254 mm) wide.
 5. Glazing Stops: Square.
 6. Finish: Same as storefront.

2.6 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Sheet Aluminum: ASTM B209/B209M.
- C. Fasteners: Stainless steel.
- D. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
- E. Glazing Accessories: See Section 08 80 00.
- F. Touch-Up Primer for Galvanized Steel Surfaces: SSPC-Paint 20, zinc rich.

2.7 FINISHES

- A. Class II Natural Anodized Finish: AAMA 611 AA-M12C22A31 Clear anodic coating not less than 0.4 mils (0.01 mm) thick.

2.8 HARDWARE

- A. For each door, include weatherstripping, sill sweep strip, and threshold.
- B. Other Door Hardware: See Section 08 71 00.
- C. Weatherstripping: Wool pile, continuous and replaceable; provide on all doors.
- D. Sill Sweep Strips: Resilient seal type, retracting, of neoprene; provide on all doors.
- E. Threshold: Extruded aluminum, one piece per door opening, ribbed surface; provide on all doors.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify that storefront wall openings and adjoining water-resistive and/or air barrier seal materials are ready to receive work of this section.

3.2 INSTALLATION

- A. Install wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
- H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- I. Set thresholds in bed of sealant and secure.
- J. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.3 TOLERANCES

- A. Maximum Variation from Plumb: 0.06 inch per 3 feet (1.5 mm per m) non-cumulative or 0.06 inch per 10 feet (1.5 mm per 3 m), whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch (0.8 mm).

3.4 ADJUSTING

- A. Adjust operating hardware and sash for smooth operation.

3.5 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, and take care to remove dirt from corners and to wipe surfaces clean.
- C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.6 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION 08 43 13

SECTION 08 42 29
AUTOMATIC ENTRANCES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Swinging type packaged power-operated door assemblies.
- B. Operators for doors provided in other sections.
- C. Controllers, actuators and safety devices.

1.2 RELATED REQUIREMENTS

- A. Section 28 46 00 - Fire Detection and Alarm: Connection to fire alarm system.

1.3 DEFINITIONS

- A. AAADM: American Association of Automatic Door Manufacturers.

1.4 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- B. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen 2004 (Reapproved 2012).
- C. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes 2020.
- D. BHMA A156.10 - American National Standard for Power Operated Pedestrian Doors 2017.
- E. BHMA A156.19 - American National Standard for Power Assist and Low Energy Power Operated Swinging Doors 2019.
- F. ITS (DIR) - Directory of Listed Products current edition.
- G. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL (DIR) - Online Certifications Directory Current Edition.
- I. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems Current Edition, Including All Revisions.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate layout and dimensions; head, jamb, and sill conditions; elevations; components, anchorage, recesses, materials, and finishes, electrical characteristics and connection requirements.
 - 2. Identify installation tolerances required, assembly conditions, routing of service lines and conduit, and locations of operating components and boxes.
- C. Product Data: Include system components, sizes, features, and finishes.
- D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and manufacturer's hardware and component templates.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.
- G. Project Record Documents: Record actual locations of concealed equipment, services, and conduit.
- H. Maintenance Data: Include manufacturer's parts list and maintenance instructions for each type of hardware and operating component.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience, and a member of AAADM.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience and approved by manufacturer.

1.7 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide two-year manufacturer warranty for [_____]. Complete forms in Owner's name and register with manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Door Operators for Swing Doors Specified in Other Sections:
 - 1. LCN, an Allegion brand; Senior Swing 2800 and 9500 Series: www.allegion.com/us.
 - a. Senior Swing 2800 and 9500 Series.
 - 2. Substitutions: Not permitted. LCN Automatic Door Operator is a Board of Trustees Approved Sole Source Item. No substitutions will be accepted.

2.2 POWER OPERATED DOORS

- A. Power Operated Doors: Provide products that comply with NFPA 101 and requirements of authorities having jurisdiction; provide equipment selected for actual door weight and for light pedestrian traffic, unless otherwise indicated.
 - 1. Swinging Fire Door Operators: In addition to other requirements, provide equipment ITS (DIR) or UL (DIR) listed as a fire door operator with automatic closer.
 - 2. Swinging Door Operators: Fully adjustable for opening and closing speeds, checking speeds, and hold-open time; in the event of power failure, disengage operator allowing door to function as a door with a spring closer.
 - 3. Packaged Door Assemblies: Provide components by single manufacturer, factory-assembled, including doors, frames, operators, actuators, and safeties.
 - a. Finish exposed equipment components to match door and frame finish.
 - 4. Air Leakage: Maximum of 1.0 cu ft/min/sq ft (5.0 L/s/sq m) of wall area, when tested in accordance with ASTM E283 at 1.57 lbs/sq ft (75 Pa) pressure differential across assembly.
 - 5. Wind-Borne-Debris Resistance: Where indicated, provide identical full-size glazed assembly without auxiliary protection tested by independent agency in accordance with ASTM E1996 for Wind Zone 4 - Additional Protection for Large and Small Missile impact and pressure cycling at design wind pressure.
 - 6. Exterior Swinging Doors: Provide equipment capable of operating, closing, and holding doors closed under positive and negative differential pressure; if necessary, provide power closing.
- B. Swinging Doors with Full Power Operators: Comply with BHMA A156.10; safeties required.
 - 1. Comply with UL 325; acceptable evidence of compliance includes UL (DIR) or ITS (DIR) listing or test report by testing agency acceptable to authorities having jurisdiction.
 - 2. Force Required to Set Door in Motion When Unpowered: 30 pound-force (133 N), maximum, measured at 1 inch (25.4 mm) from the latch edge of the door at any point in the closing cycle.
- C. Swinging Doors with Power-Assist Operators: Comply with BHMA A156.19; operator activated by pushing or pulling the door, not by any separate actuator or sensor; safeties not required.
 - 1. Force Required to Prevent Door From Closing: 15 pound-force (67 N), maximum, measured from the latch edge of the door at any point in the closing cycle.
 - 2. Force Required to Release Latch, if Any, When Unpowered: 15 pound-force (67 N), maximum, measured at 1 inch (25.4 mm) from the latch edge of the door at any point in the swing cycle.
 - 3. Force Required to Fully Open Door When Unpowered: 15 pound-force (67 N), maximum, measured at 1 inch (25.4 mm) from the latch edge of the door at any point in the closing cycle.



2.3 AUTOMATIC ENTRANCE DOOR ASSEMBLIES

- A. Comply with ADA Standards for egress requirements.

2.4 OPERATORS FOR SWINGING DOORS PROVIDED BY OTHERS

- A. Door Operator: Electric, surface mounted overhead.
 - 1. Operation: Full-power open, spring close operation.
 - 2. Variable speed control for opening and closing cycles.
 - 3. Push-Side Actuator: Push plate.
 - 4. Pull-Side Actuator: Push plate.
 - 5. Pull-Side Safety: Door-mounted.
 - 6. Hold Open: Toggle switch at inside head of doors; deactivate hold-open on activation of fire alarm system, see Section 28 46 00.
 - 7. Place automatic entrance door push plate on the adjacent wall if possible (District preference).

2.5 CONTROLLERS, ACTUATORS, AND SAFETIES

- A. Controller: Provide microprocessor operated controller for each door.
- B. Comply with BHMA A156.10 for actuator and safety types and zones.
- C. Push Plate Actuator: Standard wall mounted, surface mounted momentary contact type; satin stainless steel plate; 6 inches (152.4 mm) diameter; labeled PUSH.

2.6 ACCESSORIES

- A. Extended Length Actuator Switches:
 - 1. LCN 8310-836T.
 - 2. BEA L10PR35-HW
- B. Electric Strikes: Furnish only at Auto Operator Restrooms Doors.
 - 1. HES 1006CLB (Furnish at Multi-Occupant Restroom Doors equipped with Mortice Lock).
 - 2. HES 1006CDB (Furnish at Single Restroom Doors equipped with Mortise Privacy Deadbolt Lock).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that electric power is available and is of the correct characteristics.

3.2 INSTALLATION

- A. Install equipment in accordance with manufacturer's instructions.
- B. Provide for thermal expansion and contraction of door and frame units and live and dead loads that may be transmitted to operating equipment.
- C. Provide for dimensional distortion of components during operation.
- D. Install pneumatic lines and door power units in a manner to prevent condensation or freezing.
- E. Coordinate installation of components with related and adjacent work; level and plumb.

3.3 ADJUSTING

- A. Adjust door equipment for correct function and smooth operation.

3.4 CLEANING

- A. Remove temporary protection, clean exposed surfaces.

3.5 CLOSEOUT ACTIVITIES

- A. Demonstrate operation, operating components, adjustment features, and lubrication requirements.

3.6 MAINTENANCE

- A. Provide service and maintenance of operating equipment for one year from Date of Substantial Completion, at no extra charge to Owner.



END OF SECTION 08 42 29

SECTION 08 49 50
FIELD TESTING OF GLAZED WALL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Field testing of aluminum-framed entrances and storefronts.
- B. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections specified in this Section.

1.2 RELATED SECTIONS

- A. Section 08 40 00 – Entrances, Storefronts, and Curtain Walls
 - 1. Section 08 43 13 – Aluminum-Framed Storefronts
 - 2. Section 08 44 00 – Curtain Wall and Glazed Assemblies.
 - 3. Related Subsections (as applicable) under Section 08 40 00.

1.3 REFERENCES

- A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.
- B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC Chapter 35 and CFC Chapter 80.
- C. Referenced Standards:
 - 1. AAMA 501.2-09 – Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems.
 - 2. AAMA 502-12 – Voluntary Specification for Field Testing of Newly Installed Fenestration Products.
 - 3. ASTM E1105-08 – Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.

1.4 SUBMITTALS

- A. General: Submit under provisions of Division 01.
- B. Submit narrative of test procedures to be used, including a step-by-step outline of the test procedure.
- C. Submit schematic diagrams of test apparatus, including description of all components.
- D. Submit test reports, photographs, and video as specified in this Section.
- E. Submit certification that all tests were performed in accordance with AAMA 501.2-09, AAMA 502-12, and ASTM E1105-08.
- F. Submit shop drawings showing modifications and corrective measures required to meet specified performance criteria.

1.5 TESTING AGENCY

- A. Contractor shall engage an independent testing agency, acceptable to the Architect, for field testing of fenestration systems listed in this Section.
 - 1. The Architect reserves the right to accept or reject the testing agency proposed by Contractor.
- B. Costs: All costs of field testing including chamber preparation, testing costs, test reports, certifications, shop drawings, and related services shall be the sole responsibility of Contractor.
- C. Contractor shall make building components available at the jobsite for testing and inspection, provide temporary work as needed, and coordinate work schedule with the testing agency.



1.6 GLAZED WALL SYSTEM FIELD TEST METHOD

- A. Conduct field testing of the following completed glazed systems in accordance with AAMA 501.2-09, AAMA 502-12, and ASTM E1105-08. Assemblies to be tested:
 - 1. Aluminum-framed entrances storefronts.
 - 2. Glazed aluminum curtain walls.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Field testing apparatus shall consist of sealing a chamber to the interior face of specimen to be tested, exhausting air from the chamber at the rate required to maintain the pressure difference across the specimen while spraying water onto the outdoor face of the specimen at the required rate, and observing and documenting any water penetration.

2.2 FABRICATION

- A. Field Testing Apparatus Components:
 - 1. Test Chamber:
 - a. Provide a chamber or box made of plywood, plastic, or other suitable material and sealed against the interior face of the test specimen. Interior surfaces and joints of the specimen shall be easily observed for any water penetration during the test.
 - b. Provide observation ports of sufficient size and number to permit thorough examination of all interior surfaces and joints of the test assembly during the testing periods, in accordance with the safety requirements of the testing agency.
 - c. No part of the testing chamber shall come in contact with or restrict any point where water penetration may occur.
 - d. Provide at least one static air pressure tap to measure the chamber air pressure versus the ambient (interior-exterior) air pressure. Tap shall be located where the reading is unaffected by exterior impinging wind, or by the velocity of air supply to or from the chamber.
 - e. Provide access to the interior of the chamber to allow for close inspection of the test assembly during and following the water penetration performance tests.
 - 2. Air System: Provide a controllable blower, compressed air supply exhaust system, or reversible blower designed to supply the required maximum air pressure difference across the specimen, at a constant airflow, and at a fixed pressure for the required test period.
 - 3. Instruments and Gauges: Provide suitable instruments and gauges, calibrated and positioned to indicate face pressure on glass, water introduction rate, and other measurements as required by AAMA 501.2-09, AAMA 502-12, and ASTM E1105-08.
 - 4. Water Spray System:
 - a. Provide a water-spray system capable of delivering water uniformly against the exterior surface of the test specimen at a rate of five gallons per square foot per hour.
 - b. Water-spray system water nozzles shall be spaced on a uniform grid, located at a uniform distance from the test specimen and shall be adjustable to provide the specified quantity of water in such a manner as to wet the entire test specimen uniformly, and to wet those areas vulnerable to water penetration. Provide additional nozzles as needed in accordance with ASTM E1105-08.
 - c. Provide pressure gauge and pressure adjusting valves.



PART 3 - EXECUTION

3.1 TESTING

- A. Contractor shall notify the Architect in writing a minimum of two weeks prior to start of erection of the first typical glazed wall section. At that time, the Contractor shall provide notification to and description of the test agency and procedures to be used, including a step-by-step outline of the test procedure with schematic diagrams of test apparatus. No testing shall be performed on the specimen without Architect's acceptance of the testing materials and procedures to be employed.
- B. Number of Tests:
 - 1. One test shall be performed when approximately ten percent of each type of glazed wall system has been erected. A second test shall be performed when approximately fifty percent of the glazed wall system is in place. Depending on the results from the first two tests, a third test shall be performed at the discretion of the Architect.
 - 2. Depending upon the prevalence or absence of leakage in the initial water penetration test and upon measures taken by Contractor to eliminate sources of leakage from subsequently erected work, the Architect will determine the necessity for, and scope of additional tests. However, in no case will the total tested area be less than one percent of the glazed wall system area, except as subsequently directed by the Architect.
 - 3. At the Architect's discretion, specific non-typical areas or components of the exterior glazed wall system may be tested, in accordance with AAMA 501.2-09.

3.2 TEST OBSERVATIONS AND REPORTS

- A. Record photographs of all significant portions of testing procedure shall be taken including views of all instruments, devices, and the air chamber.
- B. Video recording of testing procedure shall be taken including ambient conditions such as temperature, wind speed, water flow rate, differential pressure, time and date, test duration, results, leakage magnitude and location, specimen description, and remedial work conducted.
- C. Furnish test diagrams for each test sequence on each specimen to illustrate the area of water spray and the location and magnitude of each type of leakage, if present.
- D. Furnish test reports including record photographs and video footage promptly to the Architect for review.
- E. Failed Tests:
 - 1. Failing results of any test shall not in any way negate the satisfactory completion of earlier tests.
 - 2. Provide all pertinent information on failing test results such as water flow rates. Test results shall describe all failures in detail.
 - 3. Tests revealing failure of an assembly to meet specified requirements shall immediately be brought to the attention of the Architect.
 - 4. In the event of failure of test specimen to initially meet specified performance requirements, Contractor shall redesign, rework, re-fabricate, reship, and re-erect as required until no failure occurs to the satisfaction of the Architect. All costs for retesting shall be borne by Contractor.
 - 5. Incorporate accepted and successfully tested corrective measures into the assembly. Modify installed or fabricated units to include these measures.
- F. Upon completion of testing, provide shop drawings showing modifications and corrective measures required to meet specified performance criteria.

END OF SECTION 08 90 50



**SECTION 08 51 13
ALUMINUM WINDOWS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Extruded aluminum windows with fixed sash, operating sash, and infill panels.
- B. Operating hardware.

1.2 REFERENCE STANDARDS

- A. AAMA/WDMA/CSA 101/I.S.2/A440 - North American Fenestration Standard/Specification for Windows, Doors, and Skylights 2017.
- B. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site 2015.
- C. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document) 2015.
- D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
- E. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Include component dimensions, information on glass and glazing, internal drainage details, and descriptions of hardware and accessories.
- C. Shop Drawings: Indicate opening dimensions, elevations of different types, framed opening tolerances, anchorage locations, and installation requirements.
- D. Grade Substantiation: Prior to submitting shop drawings or starting fabrication, submit one of the following showing compliance with specified grade:
 - 1. Evidence of AAMA Certification.
 - 2. Evidence of WDMA Certification.
 - 3. Evidence of CSA Certification.
 - 4. Test report(s) by independent testing agency itemizing compliance and acceptable to authorities having jurisdiction.
- E. Manufacturer's Installation Instructions: Include complete preparation, installation, and cleaning requirements.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of AAMA CW-10.
- B. Protect finished surfaces with wrapping paper or strippable coating during installation. Do not use adhesive papers or sprayed coatings that bond to substrate when exposed to sunlight or weather.

1.6 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C).

- B. Maintain this minimum temperature during and 24 hours after installation of sealants.

1.7 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Correct defective work within a five year period after Date of Substantial Completion.
- C. Manufacturer Warranty: Provide 5-year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units. Complete forms in Owner's name and register with manufacturer.
- D. Manufacturer Warranty: Provide 20-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Kawneer.
- B. Other Acceptable - Aluminum Windows Manufacturers:
 - 1. TriFab 451 (fixed).
 - 2. 7225 (operable hopper).

2.2 ALUMINUM WINDOWS

- A. Aluminum Windows: Extruded aluminum frame and sash, factory fabricated, factory finished, with operating hardware, related flashings, and anchorage and attachment devices.
 - 1. Frame Depth: 3-1/2 inch (89 mm).
 - 2. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for operating hardware and imposed loads.
 - 3. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
 - 4. Movement: Accommodate movement between window and perimeter framing and deflection of lintel, without damage to components or deterioration of seals.
 - 5. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
- B. Fixed, Non-Operable Type:
 - 1. Construction: Non-thermally broken.
 - 2. Exterior Finish: Class I natural anodized.
 - 3. Interior Finish: Class I natural anodized.
- C. Inswinging Hopper Type:
 - 1. Construction: Non-thermally broken.
 - 2. Provide screens.
 - 3. Exterior Finish: Class I natural anodized.
 - 4. Interior Finish: Class I natural anodized.

2.3 PERFORMANCE REQUIREMENTS

- A. Grade: AAMA/WDMA/CSA 101/I.S.2/A440 requirements for specific window type:
 - 1. Performance Class (PC): R.

2.4 COMPONENTS

- A. Glazing: See Section 08 8000.
- B. Operable Sash Weatherstripping: Wool pile; permanently resilient, profiled to achieve effective weather seal.

- C. Fasteners: Stainless steel.
- D. Glazing Materials: See Section 08 80 00.
- E. Sealant for Setting Sills and Sill Flashing: Non-curing butyl type.

2.5 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.

2.6 HARDWARE

- A. Motorized Operator: Clearline P/N 1992 Power Range actuator system, interlocked to mechanical controls; Silver. (www.clearline.com).

2.7 FINISHES

- A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils (0.018 mm) thick.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that wall openings and adjoining water-resistive barrier materials are ready to receive aluminum windows; see Section 07 25 00.

3.2 PRIME WINDOW INSTALLATION

- A. Install windows in accordance with manufacturer's instructions.
- B. Install window assembly in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.
- C. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.
- D. Align window plumb and level, free of warp or twist. Maintain dimensional tolerances and alignment with adjacent work.
- E. Install sill and sill end angles.
- F. Provide thermal isolation where components penetrate or disrupt building insulation. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- G. Install operating hardware not pre-installed by manufacturer.
- H. Install glass and infill panels in accordance with requirements; see Section 08 80 00.

3.3 TOLERANCES

- A. Maximum Variation from Level or Plumb: 1/16 inches every 3 ft (1.5 mm/m) non-cumulative or 1/8 inches per 10 ft (3 mm/3 m), whichever is less.

3.4 ADJUSTING

- A. Adjust hardware for smooth operation and secure weathertight closure.

3.5 CLEANING

- A. See Section 01 74 19 - Construction Waste Management and Disposal for additional requirements.
- B. Remove protective material from factory finished aluminum surfaces.
- C. Wash surfaces by method recommended and acceptable to window manufacturer; rinse and wipe surfaces clean.
- D. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.
- E. Remove excess glazing sealant by moderate use of mineral spirits or other solvent acceptable to sealant and window manufacturer.

END OF SECTION 08 51 13

**SECTION 08 62 23
TUBULAR SKYLIGHTS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Tubular skylights, consisting of skylight dome, reflective tube, and diffuser assembly.

1.2 REFERENCE STANDARDS

- A. AAMA/WDMA/CSA 101/I.S.2/A440 - North American Fenestration Standard/Specification for Windows, Doors, and Skylights 2017.
- B. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2021.
- C. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position 2018.
- D. ASTM E108 - Standard Test Methods for Fire Tests of Roof Coverings 2020a.
- E. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen 2019.
- F. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference 2000 (Reapproved 2016).
- G. UL 790 - Standard for Standard Test Methods for Fire Tests of Roof Coverings Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings: Indicate configurations, dimensions, locations, fastening methods, and installation details.
- D. Grade Substantiation: Prior to submitting shop drawings or starting fabrication, submit one of the following showing compliance with specified grade:
 - 1. Evidence of AAMA Certification.
 - 2. Evidence of WDMA Certification.
 - 3. Evidence of CSA Certification.
 - 4. Test report(s) by independent testing agency itemizing compliance and acceptable to authorities having jurisdiction.
- E. Test Reports: Prior to submitting shop drawings or starting fabrication, submit test report(s) by independent testing agency showing compliance with performance requirements in excess of those prescribed by specified grade.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with not less than ten years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.6 FIELD CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.7 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Skylights: Manufacturer's standard warranty for 10 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Solatube International, Inc; www.solatube.com.

2.2 TUBULAR SKYLIGHTS

- A. Tubular Skylights: Transparent roof-mounted skylight dome and curb, reflective tube, and ceiling level diffuser assembly, transferring sunlight to interior spaces.
 - 1. Fabrication and assembly of components is by single manufacturer.
 - 2. Non-Metal Parts: Flammability less than the following.
 - a. Roof-Top Components: Class B when tested in accordance with ASTM E108 or UL 790.
 - b. Combustibility - Light Transmitting Parts: Minimum 2.5 inches/min (64 mm/min) (ICC Class CC-2), when tested in accordance with ASTM D635.
- B. Roof Assemblies: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube.
 - 1. Glazing: Acrylic plastic, 1/8 inch (3.2 mm) minimum thickness.
 - 2. Dome Ring: Attached to top of base section; 0.090 inch (2.3 mm) nominal thickness injection molded high impact ABS; to prevent thermal bridging between base flashing and tubing and channel condensed moisture out of tubing; weather seal of medium density pile weather stripping.
- C. Reflective Tube: ASTM B209/B209M aluminum sheet, thickness between 0.015 inch (0.4 mm) and 0.020 inch (0.5 mm).
- D. Diffuser Assemblies: Supporting light transmitting surface at bottom termination of tube, with compression seal to minimize condensation and bug or dirt infiltration.
 - 1. Ceiling Ring: Edge trim for ceiling opening; injection molded high impact ABS.
 - 2. Diffuser Trim: Edge and attachment trim for diffuser lens; injection molded high impact ABS.
 - 3. Lens: Flush frosted lens.
 - 4. Lens Material: Acrylic plastic.
 - 5. Visible Light Transmission (VLT): 90 percent, minimum.
 - 6. Seal: Closed cell EPDM foam rubber.
- E. Delivery Zone Options:
 - 1. Local Dimmer Control utilizing a butterfly baffle design of Spectralight Infinity reflective material to minimize shadowing when in use: Provide with dimmer switch and cable.

2.3 PERFORMANCE REQUIREMENTS

- A. Grade: AAMA/WDMA/CSA 101/I.S.2/A440 requirements for specific tubular skylight:
 - 1. Product Type: Tubular Daylighting Device, Closed Ceiling (TDDCC).
- B. Design Pressure (DP): In accordance with applicable codes.
- C. Air Leakage: 0.30 cfm/sq ft (1.5 L/sec sq m) maximum leakage for tubular skylight unit when tested at 1.57 psf (75 Pa) pressure difference in accordance with ASTM E283/E283M.
- D. Water Resistance: No uncontrolled water leakage at 6.27 psf (300 Pa) pressure differential with water rate of 5 gallons/h/sf (206 L/h/sq m), when tested in accordance with ASTM E331; design to ensure that water will not accumulate inside assembly.

2.4 ACCESSORIES

- A. Fasteners: Same material as metals being fastened, non-magnetic steel, non-corrosive metal of type recommended by manufacturer, or injection molded nylon.
- B. Sealant: Elastomeric, silicone or polyurethane; compatible with materials being sealed.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's written instructions.
- B. Set roof assembly flashing in continuous bead of sealant.
- C. Seal joints exposed to weather in accordance with sealant manufacturer's written instructions.
- D. Conduct field test for water tightness; conduct water test in presence of Architect. Correct defective work and re-test until satisfactory.

3.4 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 08 62 23

SECTION 08 71 00
DOOR HARDWARE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hardware for wood, aluminum, and hollow metal doors.
- B. Hardware for fire-rated doors.
- C. Electrically operated and controlled hardware.
- D. Thresholds.
- E. Weatherstripping and gasketing.

1.2 RELATED REQUIREMENTS

- A. Section 07 92 00 - Joint Sealants: Sealants for setting exterior door thresholds.
- B. Section 08 06 71 - Door Hardware Schedule: Schedule of door hardware sets.
- C. Section 08 11 13 - Hollow Metal Doors and Frames.
- D. Section 08 11 16 - Aluminum Doors and Frames.
- E. Section 08 14 16 - Flush Wood Doors.
- F. Section 08 43 13 - Aluminum-Framed Storefronts: Door hardware, except as noted in section.
- G. Section 28 13 00 – Electronic Access Control

1.3 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- B. BHMA A156.1 - American National Standard for Butts and Hinges 2016.
- C. BHMA A156.3 - American National Standard for Exit Devices 2014.
- D. BHMA A156.4 - American National Standard for Door Controls - Closers 2013.
- E. BHMA A156.6 - American National Standard for Architectural Door Trim 2015.
- F. BHMA A156.7 - American National Standard for Template Hinge Dimensions 2016.
- G. BHMA A156.13 - American National Standard for Mortise Locks & Latches Series 1000 2017.
- H. BHMA A156.16 - American National Standard for Auxiliary Hardware 2018.
- I. BHMA A156.21 - American National Standard for Thresholds 2014.
- J. BHMA A156.25 - American National Standard for Electrified Locking Devices 2018.
- K. BHMA A156.26 - American National Standard for Continuous Hinges 2017.
- L. BHMA A156.36 - American National Standard for Auxiliary Locks 2016.
- M. DHI (H&S) - Sequence and Format for the Hardware Schedule 1996.
- N. DHI (LOCS) - Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames 2004.
- O. DHI WDHS.3 - Recommended Locations for Architectural Hardware for Flush Wood Doors 1993; also in WDHS-1/WDHS-5 Series, 1996.
- P. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.
- Q. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- R. NFPA 80 - Standard for Fire Doors and Other Opening Protectives 2019.
- S. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

- T. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies 2017.
- U. UL (DIR) - Online Certifications Directory Current Edition.
- V. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the manufacture, fabrication, and installation of products that door hardware is installed on.
- B. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.
- C. Preinstallation Meeting: Convene a preinstallation meeting one week prior to commencing work of this section; attendance is required by affected installers and the following:
 - 1. Architect.
 - 2. Installer's Architectural Hardware Consultant (AHC).
 - 3. Hardware Installer.
 - 4. Owner's Security Consultant.
- D. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.
- E. Keying Requirements Meeting:
 - 1. Schedule meeting at project site prior to Contractor occupancy.
 - 2. Attendance Required:
 - 3. Agenda:
 - 4. Incorporate "Keying Requirements Meeting" decisions into keying submittal upon review of door hardware keying system including, but not limited to, the following:
 - 5. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.
 - 6. Deliver established keying requirements to manufacturers.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project, and includes construction details, material descriptions, finishes, and dimensions and profiles of individual components.
- C. Shop Drawings - Door Hardware Schedule: Submit detailed listing that includes each item of hardware to be installed on each door. Use door numbering scheme as included in Contract Documents.
 - 1. Prepared by or under supervision of Architectural Hardware Consultant (AHC).
 - 2. Comply with DHI (H&S) using door numbers and hardware set numbers as indicated in construction documents.
 - 3. List groups and suffixes in proper sequence.
 - 4. Provide complete description for each door listed.
- D. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- E. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
 - 1. Submit manufacturer's parts lists and templates.
- F. Keying Schedule:
 - 1. Submit three (3) copies of Keying Schedule in compliance with requirements established during Keying Requirements Meeting unless otherwise indicated.
- G. Manufacturer's qualification statement.
- H. Installer's qualification statement.



- I. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- J. Project Record Documents: Record actual locations of concealed equipment, services, and conduit.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified for commercial door hardware with at least three years of documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Package hardware items individually; label and identify each package with door opening code to match door hardware schedule.

1.8 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Warranty against defects in material and workmanship for period indicated, from Date of Substantial Completion.
 - 1. Closers: Five years, minimum.
 - 2. Exit Devices: Three years, minimum.
 - 3. Locksets and Cylinders: Three years, minimum.
 - 4. Other Hardware: Two years, minimum.

PART 2 - PRODUCTS

2.1 DESIGN AND PERFORMANCE CRITERIA

- A. Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.
- B. Provide individual items of single type, of same model, and by same manufacturer.
- C. Provide door hardware products that comply with the following requirements:
 - 1. Applicable provisions of federal, state, and local codes.
 - 2. Accessibility: ADA Standards and ICC A117.1.
 - 3. Applicable provisions of NFPA 101.
 - 4. Fire-Rated Doors: NFPA 80, listed and labeled by qualified testing agency for fire protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
 - 5. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified.
- D. Electrically Operated and/or Controlled Hardware: Provide necessary power supplies, power transfer hinges, relays, and interfaces as required for proper operation; provide wiring between hardware and control components and to building power connection in compliance with NFPA 70.
 - 1. Provide electrified hardware at all doors. Door pairs shall include electrified locking hardware at both leaves.
 - 2. See Section 28 10 00 for additional access control system requirements.
- E. Fasteners:
 - 1. Provide fasteners of proper type, size, quantity, and finish that comply with commercially recognized standards for proposed applications.
 - a. Aluminum fasteners are not permitted.
 - b. Provide phillips flat-head screws with heads finished to match door surface hardware unless otherwise indicated.
 - 2. Fire-Rated Applications: Comply with NFPA 80.
 - a. Provide wood or machine screws for hinges mortised to doors or frames, strike plates to frames, and closers to doors and frames.

- b. Provide steel through bolts for attachment of surface mounted closers, hinges, or exit devices to door panels unless proper door blocking is provided.
- F. Special Requirements
 - 1. Single-Occupant Restroom
 - a. Locking mechanism shall indicate "Occupied" or "Vacant".
 - b. Locking mechanism indicating "Occupied" shall not be capable of being overridden by Access Control otherwise permitting access while in "Vacant" condition.
 - c. Locking mechanism indicating "Occupied" shall only be capable of being overridden by Access Control for Emergency Purposes.
 - d. Locking mechanism in all conditions shall be capable of being overridden by Physical Key.

2.2 HINGES

- A. Butt Hinges at Interior Doors only. Heavy-Weight required at Exit Devices, Multi-Occupant Restrooms and doors greater than 36 inches wide.
- B. Manufacturers:
 - 1. McKinney; an Assa Abloy Group company; www.assaabloydss.com.
 - 2. Hager Companies; www.hagerco.com.
 - 3. Ives, an Allegion brand; www.allegion.com/us.
- C. Hinges: Comply with BHMA A156.1, Grade 1.
 - 1. Butt Hinges: Comply with BHMA A156.1 and BHMA A156.7 for templated hinges.
 - a. Provide hinge width required to clear surrounding trim.
 - b. Standard Weight:
 - 1) Hager: [BB1279](#).
 - 2) Ives: [5BB1](#).
 - 3) McKinney: [TA 2714 4.5 x 4.5 652](#).
 - c. Standard Weight Electrified:
 - 1) Hager: [BB1279-ETW8](#).
 - 2) Ives: [5BB1-TW8](#).
 - 3) McKinney: [TA2714-CC8 4.5 x 4.5 652](#).
 - d. Heavy Weight:
 - 1) Hager: [BB1168](#).
 - 2) Ives: [5BB1HW](#).
 - 3) McKinney: [T4A3786 4.5 x 4.5 652](#).
 - e. Heavy Weight Electrified:
 - 1) Hager: [BB1168-ETW8](#).
 - 2) Ives: [5BB1HW-TW8](#).
 - 3) McKinney: [T4A3786-CC8 4.5 x 4.5](#).
 - 2. Continuous Hinges: Comply with BHMA A156.26.
 - a. Continuous Hinges required at all Exterior Openings.
 - 1) Pemko: [CFM-HD1](#) with Lifetime Warranty x (EPT with EPT10 Transfer for use with QEL Exit Devices)
 - 3. Provide hinges on every swinging door.

2.3 FLUSH BOLTS

- A. Manufacturers:
 - 1. Glynn-Johnson, an Allegion brand; www.allegion.com/us.
 - 2. Ives, an Allegion brand; www.allegion.com/us.
 - 3. Rockwood; an Assa Abloy Group company; www.assaabloydss.com.
- B. Flush Bolts: Comply with BHMA A156.16, Grade 1.
 - 1. Flush Bolt Throw: 3/4 inch (19 mm), minimum.
 - 2. Provides extension bolts in leading edge of door, one bolt into floor, one bolt into top of frame.

- a. Pairs of Swing Doors: At inactive leaves, provide flush bolts of type as required to comply with code.
3. Provide dustproof floor strike for bolt into floor, except at metal thresholds.
4. Automatic Flush Bolts: Automatically latch upon closing of door; automatic retraction of bolts when active leaf is opened; located on inactive leaf of pair of doors.
 - a. Glynn-Johnson: [COR Series](#).
 - b. Ives: [FB 30-60](#).
 - c. Rockwood: [2842-2942 Series](#) AFB's Dust Proof Strike.

2.4 EXIT DEVICES

- A. Manufacturers:
 1. Von Duprin, an Allegion brand: www.allegion.com/us.
- B. Exit Devices: Comply with BHMA A156.3, Grade 1.
 1. Lever design to match lockset trim.
 2. Provide cylinder with cylinder dogging or locking trim.
 3. Provide exit devices properly sized for door width and height.
 4. Provide strike as recommended by manufacturer for application indicated.
 5. Provide UL (DIR) listed exit device assemblies for fire-rated doors and panic device assemblies for non-fire-rated doors.
 6. For electrical options, provide quick connect plug-in pre-wired connectors.
 - a. Rim Exit Devices at Single Doors: [Von Duprin AX-PA 98L](#) 996L Series (630 Finish).
 - b. VR Exit Devices at Door Pairs: [Von Duprin PA 9874EO](#) & PA 9847L 996L Series (630 Finish).
 - c. Electrified Exit Devices: [Von Duprin PA-RX2-QEL98](#) at Single Door and PA-RX2-QEL-9947-NL-OP at Door Pairs (Sole Source).
 - 1) "Von Duprin" is a Board of Trustees Approved Sole Source Item. No substitutions will be accepted.

2.5 LOCK CYLINDERS

- A. Manufacturers:
 1. Best, dormakaba Group: www.bestaccess.com.
- B. Lock Cylinders: Provide key access on outside of each lock, unless otherwise indicated.
 1. Provide cylinders from same manufacturer as locking device.
 2. Provide cams and/or tailpieces as required for locking devices.
 3. Cylinders: Keyed with stampings, as directed by the College.
 - a. [Best \(7-Pin SFIC removable cores\)](#).
 - b. [Best Rim Cylinder \(IE72 Series\)](#).
 - c. [Best Mortise Cylinder \(IE74 Series\)](#).

2.6 MORTISE LOCKS

- A. Manufacturers:
 1. Schlage, an Allegion brand: www.allegion.com/us.
- B. Mortise Locks: Comply with BHMA A156.13, Grade 1, Security, 1000 Series.
 1. Latchbolt Throw: 3/4 inch (19 mm), minimum.
 2. Deadbolt Throw: 1 inch (25.4 mm), minimum.
 3. Backset: 2-3/4 inch (70 mm) unless otherwise indicated.
 4. Strikes: Provide manufacturer's standard strike for each latchset or lockset with strike box and curved lip extending to protect frame in compliance with indicated requirements.
 - a. Finish: To match lock or latch.
 5. Mortise Locksets:
 - a. Mortise: [Schlage L9000 Series with 17A Lever](#) (630 Finish).
 - b. Mortise Electrified: [L9080EU RX with 17A Lever](#) (630 Finish).

- c. **"Schlage"** Mortise Locks are a **Board of Trustees Approved Sole Source Item**. No substitutions will be accepted.

2.7 AUXILIARY LOCKS (DEADLOCKS)

- A. Manufacturers:
1. Best, dormakaba Group: www.bestaccess.com.
 2. Schlage, an Allegion brand; www.allegion.com/us.
- B. Auxiliary Locks (Deadlocks): Comply with BHMA A156.36, Grade 1.
1. Type: Bored (cylindrical).
 2. Application: Bored.
 3. Backset: 2-3/4 inch (70 mm), unless otherwise indicated.
 4. Bolt Throw: 1/2 inch (12.7 mm), with latch made of hardened steel.
 5. Provide strike that matches frame.
 6. Deadbolt: Use at non-occupied rooms. Do not use at ADA Accessible or Exit Doors.
 - a. Schlage [B600 Series BD](#) (626 Finish).
 - b. [Best 83T Series](#) (626 Finish).

2.8 DOOR PULLS AND PUSH PLATES

- A. Manufacturers:
1. Rockwood; an Assa Abloy Group company: www.assaabloydss.com.
 2. Ives, an Allegion brand; www.allegion.com/us.
 3. Trimco: www.trimcohardware.com.
- B. Door Pulls and Push Plates: Comply with BHMA A156.6.
1. Pull Type: Straight, unless otherwise indicated.
 2. Push Plate Type: Flat, with square corners, unless otherwise indicated.
 - a. Edges: Beveled, unless otherwise indicated.
 3. Material: Aluminum, unless otherwise indicated.
 4. Provide door pulls and push plates on doors without a lockset, latchset, exit device, or auxiliary lock unless otherwise indicated.
 5. On glazed storefront doors, provide matching door pulls/push plates on both faces unless otherwise indicated.
 6. Door Pulls (Anti-Vandal) at Exterior HM Doors with Exit Devices:
 - a. Ives: [VR910](#).
 - b. Rockwood [VR26](#).
 - c. Trimco [1096](#).
 - d. Von Duprin: NL with Cylinders, DT without Cylinders.

2.9 CLOSERS

- A. Manufacturers; Surface Mounted:
1. LCN, an Allegion brand: www.allegion.com/us.
 2. Norton: www.nortondoortcontrols.com.
- B. Closers: Comply with BHMA A156.4, Grade 1.
1. Type: Surface mounted to door.
 2. Provide door closer on each exterior door.
 3. Door Closers: Cast-Iron Heavy Duty, non-handed with cover.
 - a. Exterior:
 - 1) [LCN 4040XP EDA AL](#).
 - 2) [Norton: PR 9500](#) 689.
 - b. Interior:
 - 1) [LCN 4040XP](#) (Knuckle type 4040XP-3049SCNS at interior non-rated openings).
 - 2) [Norton: 9540](#).

2.10 KICK PLATES

- A. Manufacturers:
 - 1. Ives, an Allegion brand: www.allegion.com/us.
 - 2. Trimco: www.trimcohardware.com.
- B. Kick Plates: Provide along bottom edge of push side of every door with closer, except aluminum storefront and glass entry doors, unless otherwise indicated.
 - 1. Size: 10 inch (254 mm) high by 2 inch (51 mm) less door width (LDW) on push side of door.
 - 2. Kick Plates:
 - a. Ives: [8400](#).
 - b. Rockwood: [K1050](#).
 - c. Trimco: [K0050](#) 10" x 1.5" LDW Counter-Sunk Fasteners.

2.11 FLOOR STOPS

- A. Manufacturers:
 - 1. Rockwood; an Assa Abloy Group company: www.assaabloydss.com.
 - 2. Trimco: www.trimcohardware.com.
- B. Floor Stops: Comply with BHMA A156.16, Grade 1 and Resilient Material Retention Test as described in this standard.
 - 1. Mount maximum 4" from adjacent wall.
 - 2. Provide floor stops when wall surface is not available; be cautious not to create a tripping hazard.
 - a. Do not use if pedestrian hazard, use Overhead.
 - 3. Type: Manual hold-open, with pencil floor stop.
 - 4. Material: Aluminum housing with rubber insert.
 - 5. Floor Stops:
 - a. Ives: [FS18S](#).
 - b. Rockwood: [463](#). Use Rockwood [441H](#) at interior.
 - c. Trimco: [1209](#).

2.12 WALL STOPS

- A. Manufacturers:
 - 1. Rockwood; an Assa Abloy Group company: www.assaabloydss.com.
 - 2. Trimco: www.trimcohardware.com.
- B. Wall Stops: Comply with BHMA A156.16, Grade 1 and Resilient Material Retention Test as described in this standard.
 - 1. Provide wall stops to prevent damage to wall surface upon opening door.
 - 2. Type: Bumper, concave, wall stop.
 - 3. Material: Aluminum housing with rubber insert.
- C. Wall Stops:
 - 1. Ives: [WS407CVX](#).
 - 2. Rockwood [406](#).
 - 3. Trimco [1270WX](#).

2.13 THRESHOLDS

- A. Thresholds: Comply with BHMA A156.21.
 - 1. Provide threshold at each exterior door, unless otherwise indicated.
 - 2. Type: Flat surface.
 - 3. Material: Aluminum.
 - 4. Threshold Surface: Fluted horizontal grooves across full width.
 - 5. Field cut threshold to profile of frame and width of door sill for tight fit.
 - 6. Provide non-corroding fasteners at exterior locations.
 - 7. Furnish with FHSL14 Anchors at exterior and MSES25SS at interior.
 - 8. Door Seals, Exterior:
 - a. Pemko: 332CS Gasket Seals; 3454 CNB Brush Door Sweeps; 346C Rain Drips.



9. Door Seals, Interior:
 - a. Pemco: S88D Smoke Seals; 368CN Door Sweep (PDB411AE/420 Door Bottoms at Acoustical Doors).

2.14 ELECTRONIC ACCESS CONTROL

1. Refer to 28 13 00 - Electronic Access Control System for all information.

2.15 FINISHES

- A. As required per project

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that doors and frames are ready to receive this work; labeled, fire-rated doors and frames are properly installed, and dimensions are as indicated on shop drawings.

3.2 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and applicable codes.
- B. Install hardware on fire-rated doors and frames in accordance with applicable codes and NFPA 80.
- C. Use templates provided by hardware item manufacturer.
- D. Door Hardware Mounting Heights: Distance from finished floor to center line of hardware item. As indicated in following list; unless noted otherwise in Door Hardware Schedule or on drawings.
 1. For Steel Doors and Frames: Install in compliance with DHI (LOCS) recommendations.
 2. For Steel Doors and Frames: See Section 08 11 13.
 3. For Aluminum-Framed Storefront Doors and Frames: See Section 08 43 13.
 4. For Wood Doors: Install in compliance with DHI WDHS.3 recommendations.
 5. Flush Wood Doors: See Section 08 14 16.
 6. Mounting heights in compliance with ADA Standards:
- E. Set exterior door thresholds with full-width bead of elastomeric sealant at each point of contact with floor providing a continuous weather seal; anchor thresholds with stainless steel countersunk screws.

3.3 FIELD QUALITY CONTROL

- A. Perform field inspection and testing under provisions of Section 01 40 00 - Quality Requirements.

3.4 ADJUSTING

- A. Adjust work under provisions of Section 01 70 00 - Execution and Closeout Requirements.
- B. Adjust hardware for smooth operation.
- C. Adjust gasketing for complete, continuous seal; replace if unable to make complete seal.

3.5 CLEANING

- A. Clean finished hardware in accordance with manufacturer's written instructions after final adjustments have been made.
- B. Clean adjacent surfaces soiled by hardware installation.
- C. Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.
- D. See Section 01 74 19 - Construction Waste Management and Disposal for additional requirements.

3.6 PROTECTION

- A. Protect finished Work under provisions of Section 01 70 00 - Execution and Closeout Requirements.
- B. Do not permit adjacent work to damage hardware or finish.

END OF SECTION 08 71 00

**SECTION 08 80 00
GLAZING**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Insulating glass units.
- B. Glazing units.
- C. Glazing compounds.

1.2 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials Current Edition.
- B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test 2015 (Reaffirmed 2020).
- C. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers 2005 (Reapproved 2019).
- D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.
- E. ASTM C1036 - Standard Specification for Flat Glass 2021.
- F. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass 2018.
- G. ASTM C1193 - Standard Guide for Use of Joint Sealants 2016.
- H. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass 2021a.
- I. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings 2016.
- J. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation 2010.
- K. GANA (SM) - GANA Sealant Manual 2008.
- L. NFRC 100 - Procedure for Determining Fenestration Product U-factors 2020.
- M. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence 2020.
- N. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems 2017.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data on Insulating Glass Unit and Glazing Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- C. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- D. Samples: Submit one samples 12 by 12 inch in size of glass units.
- E. Certificate: Certify that products of this section meet or exceed specified requirements.
- F. Manufacturer's qualification statement.
- G. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience.

1.5 FIELD CONDITIONS

- A. Do not install glazing when ambient temperature is less than 40 degrees F (4 degrees C).
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.6 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Insulating Glass Units: Provide a five (5) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Float Glass Manufacturers:
 - 1. Cardinal Glass Industries: www.cardinalcorp.com.
 - 2. Guardian Glass, LLC: www.guardianglass.com.
 - 3. Pilkington North America Inc: www.pilkington.com/na.
 - 4. Vitro Architectural Glass (formerly PPG Glass): www.vitroglazings.com.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

- A. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
 - 1. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 - 2. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
 - 3. Glass thicknesses listed are minimum.
- B. Weather-Resistive Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure water-resistive barrier, vapor retarder, and/or air barrier.
 - 1. In conjunction with weather barrier related materials described in other sections, as follows:
- C. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
 - 1. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 - 2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 - 3. Solar Optical Properties: Comply with NFRC 300 test method.

2.3 GLASS MATERIALS

- A. Float Glass: Provide float glass based glazing unless otherwise indicated.
 - 1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality - Q3.
 - 2. Kind HS - Heat-Strengthened Type: Complies with ASTM C1048.
 - 3. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.
 - 4. Tinted Type: ASTM C1036, Class 2 - Tinted, Quality - Q3, with color and performance characteristics as indicated.
 - 5. Thicknesses: As indicated; provide greater thickness as required for exterior glazing wind load design.



2.4 INSULATING GLASS UNITS

- A. Manufacturers:
 - 1. Vitro Architectural Glass (formerly PPG Glass); Basis of design: www.vitroglazings.com.
- B. Insulating Glass Units: Types as indicated.
 - 1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
 - 2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
 - 3. Spacer Color: Black.
 - 4. Edge Seal:
 - a. Dual-Sealed System: Provide polyisobutylene sealant as primary seal applied between spacer and glass panes, and silicone, polysulfide, or polyurethane sealant as secondary seal applied around perimeter.
 - b. Color: Black.
 - 5. Purge interpane space with dry air, hermetically sealed.
- C. Type IG-1 - Insulating Glass Units: Vision glass, double glazed.
 - 1. Applications: Exterior glazing unless otherwise indicated.
 - 2. Space between lites filled with argon.
 - 3. Outboard Lite: Annealed float glass, 1/4 inch (6.4 mm) thick, minimum.
 - a. Tint: Gray.
 - b. Coating: Low-E (passive type), on #2 surface.
 - 4. Inboard Lite: Annealed float glass, 1/4 inch (6.4 mm) thick, minimum.
 - a. Tint: Clear.
 - 5. Total Thickness: 1 inch (25.4 mm).
 - 6. Thermal Transmittance (U-Value), Summer - Center of Glass: 0.29, nominal.
 - 7. Visible Light Transmittance (VLT): 42 percent, nominal.
 - 8. Solar Heat Gain Coefficient (SHGC): 0.32, nominal.
 - 9. Glazing Method: Dry glazing method, gasket glazing.



2.5 BASIS OF DESIGN - INSULATING GLASS UNITS

- A. Basis of Design - Insulating Glass Units: Vision glazing, with low-e coating.
 - 1. Applications: Exterior insulating glass glazing unless otherwise indicated.
 - 2. Space between lites filled with argon.
 - 3. Total Thickness: 1 inch (25.4 mm).
 - 4. Thermal Transmittance (U-Value), Summer - Center of Glass: 0.29, nominal.
 - 5. Visible Light Transmittance (VLT): 42 percent, nominal.
 - 6. Solar Heat Gain Coefficient (SHGC): 0.32, nominal.
 - 7. Glazing Method: Dry glazing method, gasket glazing.
 - 8. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
 - 9. Spacer Color: Black.
 - 10. Edge Seal:
 - 11. Color: Black.
 - 12. Purge interpane space with dry air, hermetically sealed.
 - 13. Basis of Design - Vitro Architectural Glass (formerly PPG Glass): www.vitroglazings.com.
 - 14. Outboard Lite: Annealed float glass, 1/4 inch (6.4 mm) thick, minimum.
 - a. Low-E Coating: Vitro Architectural Glass (formerly PPG Glass) Solarban 60 on #2 surface.
 - 15. Inboard Lite: Heat-strengthened float glass, 1/4 inch (6.4 mm) thick.
 - a. Coating: No coating on inboard lite.
 - b. Glass: Clear.

2.6 GLAZING UNITS

- A. Type G-1 - Monolithic Exterior Vision Glazing:
1. Applications: Exterior glazing unless otherwise indicated.
 2. Glass Type: Annealed float glass.
 3. Tint: Solarban 60 by Vitro Glazing.
 4. Thickness: 1/4 inch (6.4 mm), nominal.
 5. Visible Light Transmittance (VLT): 70 percent, nominal.
 6. Shading Coefficient: 0.45, nominal.
 7. Solar Heat Gain Coefficient (SHGC): 0.39, nominal.
 8. Visible Light Reflectance, Outside: 11 percent, nominal.
 9. Glazing Method: Dry glazing method, gasket glazing.
 10. Manufacturers:
 - a. Vitro Architectural Glass (formerly PPG Glass).

2.7 GLAZING COMPOUNDS

- A. Type GC-1 - Glazing Putty: Polymer modified latex recommended by manufacturer for outdoor use, knife grade consistency; gray color.
- B. Type GC-2 - Butyl Sealant: Single component; ASTM C920 Grade NS, Class 12-1/2, Uses M and A, Shore A hardness of 10 to 20; black color.
- C. Type GC-3 - Polysulfide Sealant: Two component; chemical curing, nonsagging type; ASTM C920 Type M, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; color as selected.
- D. Type GC-4 - Polyurethane Sealant: Single component, chemical curing, nonstaining, nonbleeding; ASTM C920 Type S, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 20 to 35; [] color.
- E. Type GC-5 - Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; nonbleeding, nonstaining; ASTM C920 Type S, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; [] color.

2.8 ACCESSORIES

- A. Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot (25 mm for each square meter) of glazing or minimum 4 inch (100 mm) by width of glazing rabbet space minus 1/16 inch (1.5 mm) by height to suit glazing method and pane weight and area.
- B. Glazing Tape, Back Bedding Mastic Type: Preformed, butyl-based, 100 percent solids compound with integral resilient spacer rod applicable to application indicated; 5 to 30 cured Shore A durometer hardness; coiled on release paper; black color.
- C. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.

PART 3 - EXECUTION

3.1 VERIFICATION OF CONDITIONS

- A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
- B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.

3.2 PREPARATION

- A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.



- C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

3.3 INSTALLATION, GENERAL

- A. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.
- B. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.

3.4 INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

- A. Application - Exterior and/or Interior Glazed: Set glazing infills from either the exterior or the interior of the building.
- B. Place setting blocks at 1/4 points with edge block no more than 6 inch (152 mm) from corners.
- C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.
- D. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.5 CLEANING

- A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
- B. Remove nonpermanent labels immediately after glazing installation is complete.
- C. Clean glass and adjacent surfaces after sealants are fully cured.
- D. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.6 PROTECTION

- A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.
- B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION 08 80 00

**SECTION 08 83 00
MIRRORS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Glass mirrors.
 - 1. Tempered safety glass.

1.2 REFERENCE STANDARDS

- A. ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.
- B. ASTM C1036 - Standard Specification for Flat Glass 2021.
- C. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror 2018.
- D. GANA (GM) - GANA Glazing Manual 2008.
- E. GANA (SM) - GANA Sealant Manual 2008.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data on Mirror Types: Submit structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA (GM), GANA (SM), and [] for glazing installation methods.
- B. Fabricate, store, transport, receive, install, and clean mirrors in accordance with manufacturer's recommendations.

1.5 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for reflective coating on mirrors and replacement of same.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Mirror Design Criteria: Select materials and/or provide supports as required to limit mirror material deflection to 1/200, or to the flexure limit of glass, with full recovery of glazing materials, whichever is less.
- B. Mirror Glass: ASTM C1036, Type 1 - Transparent Flat, Class 1 - Clear, Quality - Q1 (high-quality mirrors); silvering, protective coating, and quality requirements in compliance with ASTM C1503.
 - 1. Thickness: 1/4 inch (6 mm).
 - 2. Size: As indicated on drawings.

2.2 GLAZING COMPOUNDS

- A. Silicone Sealant: ASTM C920, Type S, Grade NS, Class 25, Uses M and A; single component; chemical or solvent curing; non-bleeding, non-staining, cured Shore A hardness of 15 to 25; [] color.

2.3 ACCESSORIES

- A. Glazing Tape: Preformed butyl compound; 10 to 15 Shore A durometer hardness; on release paper.
- B. Mirror Adhesive: Silicone pre-polymer based, chemically compatible with mirror coating and wall substrate.

- C. Channel Frame: One piece, channel frame, stainless steel, Type 430, satin finish, 1/2 inch by 1/2 inch by 3/8 inch deep (12.7 mm by 12.7 mm by 9.5 mm deep) with 90 degree mitered corners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that openings for mirrored glazing are correctly sized and within tolerance.
B. Verify that surfaces of mirror frames or recesses are clean, free of obstructions, and ready for installation of mirrors.

3.2 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
B. Seal porous mirror frames or recesses with substrate compatible primer or sealer. Prime surfaces scheduled to receive sealant.

3.3 INSTALLATION

- A. Install mirrors in accordance with manufacturer's recommendations.
B. Set mirrors plumb and level, and free of optical distortion.
C. Set mirrors with edge clearance free of surrounding construction including countertops or backsplashes.

3.4 CLEANING

- A. Remove wet glazing materials from finish surfaces.
B. Remove labels after work is complete.
C. Clean mirrors and adjacent surfaces.

END OF SECTION 08 83 00

SECTION 09 05 61
COMMON WORK RESULTS FOR FLOORING PREPARATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section applies to floors identified in Contract Documents that are receiving the following types of floor coverings:
 - 1. Resilient tile and sheet.
 - 2. Broadloom carpet.
 - 3. Carpet tile.
- B. Preparation of new concrete floor slabs for installation of floor coverings.
- C. Testing of concrete floor slabs for moisture and alkalinity (pH).
- D. Remediation of concrete floor slabs due to unsatisfactory moisture or alkalinity (pH) conditions.
 - 1. Contractor shall perform all specified remediation of concrete floor slabs. If such remediation is indicated by testing agency's report and is due to a condition not under Contractor's control or could not have been predicted by examination prior to entering into the contract, a contract modification will be issued.
- E. Patching compound.
- F. Remedial floor coatings.

1.2 REFERENCE STANDARDS

- A. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens) 2021.
- B. ASTM C472 - Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete 2020.
- C. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride 2016a.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate scheduling of cleaning and testing, so that preliminary cleaning has been completed for at least 24 hours prior to testing.

1.4 SUBMITTALS

- A. Floor Covering and Adhesive Manufacturers' Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used; showing:
 - 1. Moisture and alkalinity (pH) limits and test methods.
 - 2. Manufacturer's required bond/compatibility test procedure.
- B. Testing Agency's Report:
 - 1. Description of areas tested; include floor plans and photographs if helpful.
 - 2. Summary of conditions encountered.
 - 3. Moisture and alkalinity (pH) test reports.
 - 4. Copies of specified test methods.
 - 5. Recommendations for remediation of unsatisfactory surfaces.
 - 6. Product data for recommended remedial coating.
 - 7. Submit report to Architect.
 - 8. Submit report not more than two business days after conclusion of testing.
- C. Adhesive Bond and Compatibility Test Report.
- D. Remedial Materials Product Data: Manufacturer's published data on each product to be used for remediation.



1.5 QUALITY ASSURANCE

- A. Moisture and alkalinity (pH) testing will be performed by an independent testing agency employed and paid by Owner.
- B. Testing Agency Qualifications: Independent testing agency experienced in the types of testing specified.
 - 1. Submit evidence of experience consisting of at least 3 test reports of the type required, with project Owner's project contact information.
- C. Contractor's Responsibility Relating to Independent Agency Testing:
 - 1. Provide access for and cooperate with testing agency.
 - 2. Confirm date of start of testing at least 10 days prior to actual start.
 - 3. Allow at least 4 business days on site for testing agency activities.
 - 4. Achieve and maintain specified ambient conditions.
 - 5. Notify Owner when specified ambient conditions have been achieved and when testing will start.

1.6 FIELD CONDITIONS

- A. Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 65 degrees F (18 degrees C) or more than 85 degrees F (30 degrees C).
- B. Maintain relative humidity in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 40 percent and not more than 60 percent.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Patching Compound: Floor covering manufacturer's recommended product, suitable for conditions, and compatible with adhesive and floor covering. In the absence of any recommendation from flooring manufacturer, provide a product with the following characteristics:
 - 1. Cementitious moisture-, mildew-, and alkali-resistant compound, compatible with floor, floor covering, and floor covering adhesive, and capable of being feathered to nothing at edges.
 - 2. Compressive Strength: 3000 psi, minimum, after 28 days, when tested in accordance with ASTM C109/C109M or ASTM C472, whichever is appropriate.
- B. Alternate Flooring Adhesive: Floor covering manufacturer's recommended product, suitable for the moisture and pH conditions present; low-VOC. In the absence of any recommendation from flooring manufacturer, provide a product recommended by adhesive manufacturer as suitable for substrate and floor covering and for conditions present.
- C. Remedial Floor Coating: Single- or multi-layer coating or coating/overlay combination intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.
 - 1. Thickness: As required for application and in accordance with manufacturer's installation instructions.
 - 2. Use product recommended by testing agency.
 - 3. Products:
 - a. Koster American Corporation; [Koster VAP | 2000](#) with [Koster SL Premium](#) overlay: www.kosterusa.com.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.



PART 3 - EXECUTION

3.1 CONCRETE SLAB PREPARATION

- A. Follow recommendations of testing agency.
- B. Perform following operations in the order indicated:
 - 1. Preliminary cleaning.



2. Moisture vapor emission tests; 3 tests in the first 1000 square feet (100 square meters) and one test in each additional 1000 square feet (100 square meters), unless otherwise indicated or required by flooring manufacturer.
 3. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
 4. Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
 5. Specified remediation, if required.
 6. Patching, smoothing, and leveling, as required.
 7. Other preparation specified.
 8. Adhesive bond and compatibility test.
 9. Protection.
- C. Remediations:
1. Active Water Leaks or Continuing Moisture Migration to Surface of Slab: Correct this condition before doing any other remediation; re-test after correction.
 2. Excessive Moisture Emission or Relative Humidity: If an adhesive that is resistant to the level of moisture present is available and acceptable to flooring manufacturer, use that adhesive for installation of the flooring; if not, apply remedial floor coating or remedial sheet membrane over entire suspect floor area.
 3. Excessive Alkalinity (pH): If remedial floor coating is necessary to address excessive moisture, no additional remediation is required; if not, if an adhesive that is resistant to the level present is available and acceptable to the flooring manufacturer, use that adhesive for installation of the flooring; otherwise, apply a skim coat of specified patching compound over entire suspect floor area.

3.2 MOISTURE VAPOR EMISSION TESTING

- A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
- B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.
- C. Test in accordance with ASTM F1869 and as follows.
- D. Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.
- E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if test values exceed 3 pounds per 1000 square feet (1.4 kg per 93 square meters) per 24 hours.
- F. Report: Report the information required by the test method.

3.3 ALKALINITY TESTING

- A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
- B. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if alkalinity (pH) test value is over 10.

3.4 PREPARATION

- A. See individual floor covering section(s) for additional requirements.
- B. Comply with requirements and recommendations of floor covering manufacturer.
- C. Fill and smooth surface cracks, grooves, depressions, control joints and other non-moving joints, and other irregularities with patching compound.
- D. Do not fill expansion joints, isolation joints, or other moving joints.



3.5 ADHESIVE BOND AND COMPATIBILITY TESTING

- A. Comply with requirements and recommendations of floor covering manufacturer.

3.6 APPLICATION OF REMEDIAL FLOOR COATING

- A. Comply with requirements and recommendations of coating manufacturer.

3.7 INSTALLATION OF REMEDIAL FLOOR SHEET MEMBRANE

- A. Install in accordance with sheet membrane manufacturer's instructions.

3.8 PROTECTION

- A. Cover prepared floors with building paper or other durable covering.

END OF SECTION 09 05 61

**SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Performance criteria for gypsum board assemblies.
- B. Metal stud wall framing.
- C. Metal channel ceiling framing.
- D. Gypsum sheathing.
- E. Cementitious backing board.
- F. Gypsum wallboard.
- G. Joint treatment and accessories.
- H. Textured finish system.
- I. Acoustic (sound-dampening) wall and ceiling board.

1.2 RELATED REQUIREMENTS

- A. Section 07 21 00 - Thermal Insulation: Acoustic insulation.
- B. Section 07 25 00 - Weather Barriers: Water-resistive barrier over sheathing.

1.3 REFERENCE STANDARDS

- A. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method 2017.
- B. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board 2017.
- C. ASTM C514 - Standard Specification for Nails for the Application of Gypsum Board 2004 (Reapproved 2020).
- D. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board 2020.
- E. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs 2020.
- F. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base 2019.
- G. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing 2017.
- H. ASTM C1280 - Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing 2018.
- I. ASTM C1396/C1396M - Standard Specification for Gypsum Board 2017.
- J. ASTM C1658/C1658M - Standard Specification for Glass Mat Gypsum Panels 2019, with Editorial Revision (2020).
- K. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber 2016.
- L. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements 2009 (Reapproved 2016).
- M. ASTM E413 - Classification for Rating Sound Insulation 2016.
- N. ASTM E1414/E1414M - Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum 2021a.
- O. GA-216 - Application and Finishing of Gypsum Panel Products 2016, with Errata.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on gypsum board, accessories, and joint finishing system.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing gypsum board installation and finishing, with minimum three years of experience.

PART 2 - PRODUCTS

2.1 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
- B. Interior Partitions, Indicated as Acoustic: Provide completed assemblies with the following characteristics:
 - 1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

2.2 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
 - 1. American Gypsum Company: www.americangypsum.com.
 - 2. CertainTeed Corporation: www.certainteed.com.
 - 3. Georgia-Pacific Gypsum: www.gpgypsum.com.
 - 4. National Gypsum Company: www.nationalgypsum.com.
 - 5. USG Corporation: www.usg.com.
 - 6. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 - 2. Glass mat faced gypsum panels, as defined in ASTM C1658/C1658M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
 - 3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - a. Mold-resistant board is required whenever board is being installed before the building is enclosed and conditioned.
 - 4. Thickness:
 - a. Vertical Surfaces: 5/8 inch (16 mm).
 - b. Ceilings: 1/2 inch (13 mm).
 - 5. Paper-Faced Products:
 - a. American Gypsum Company; FireBloc Type X Gypsum Wallboard: www.americangypsum.com.
 - b. CertainTeed Corporation; Type X Drywall: www.certainteed.com.
 - c. Georgia-Pacific Gypsum; ToughRock Fireguard X: www.gpgypsum.com.
 - d. National Gypsum Company; Gold Bond BRAND Fire-Shield Gypsum Board: www.nationalgypsum.com.
 - e. USG Corporation; USG Sheetrock Brand Firecode X Panels: www.usg.com.
 - f. Substitutions: See Section 01 60 00 - Product Requirements.
 - 6. Mold Resistant Paper Faced Products:
 - a. CertainTeed Corporation; M2Tech 5/8" Type X Moisture & Mold Resistant Drywall: www.certainteed.com.
 - b. Georgia-Pacific Gypsum; ToughRock Fireguard X Mold-Guard: www.gpgypsum.com.
 - c. National Gypsum Company; Gold Bond XP Gypsum Board: www.nationalgypsum.com.
 - d. USG Corporation; USG Sheetrock Brand EcoSmart Panels Mold Tough Firecode X: www.usg.com.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
 - 7. Glass Mat Faced Products (at restrooms):

- a. Georgia-Pacific Gypsum; DensArmor Plus Fireguard C: www.gpgypsum.com.
 - b. National Gypsum Company; Gold Bond eXP Interior Extreme Gypsum Panel: www.nationalgypsum.com.
 - c. USG Corporation; USG Sheetrock Brand Glass-Mat Panels Mold Tough.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
1. Application: Ceilings, unless otherwise indicated.
 2. Thickness: 1/2 inch (13 mm).
 3. Edges: Tapered.
 4. Products:
 - a. CertainTeed Corporation; Interior Ceiling Drywall: www.certainteed.com.
 - b. Georgia-Pacific Gypsum; ToughRock Span 24 Ceiling Board: www.gpgypsum.com.
 - c. USG Corporation; 1/2 Inch Sheetrock Brand UltraLight Panels: www.usg.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Acoustical Sound Dampening Wall and Ceiling Board: Two layers of heavy paper-faced, high-density gypsum board separated by a viscoelastic polymer layer and capable of achieving STC rating of 50 or more in typical stud wall assemblies as calculated in accordance with ASTM E413 and when tested in accordance with ASTM E90.
1. Thickness: 1/2 inch (13 mm).
 2. Long Edges: Tapered.
 3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 4. Products:
 - a. CertainTeed Corporation; SilentFX Quick Cut Gypsum Board: www.certainteed.com.
 - b. National Gypsum Company; Gold Bond SoundBreak XP Gypsum Board: www.nationalgypsum.com.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Sound-Absorbing Gypsum Board Ceiling System: Perforated gypsum board with acoustic backer panels and spray-applied finish.
1. Thickness, Perforated Gypsum Board: 5/8 inch (16 mm).
 2. Spray-Applied Finish: Acoustically transparent, acrylic-based finish coating.
 3. Noise Reduction Coefficient (NRC): Not less than 0.80 when measured and calculated in accordance with ASTM C423.
 4. Ceiling Attenuation Class (CAC): Not less than 44 when tested in accordance with ASTM E1414/E1414M and classified in accordance with ASTM E413.
- F. Exterior Sheathing Board: Sizes to minimize joints in place; ends square cut.
1. Application: Exterior sheathing, unless otherwise indicated.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 3. Glass Mat Faced Sheathing: Glass mat faced gypsum substrate as defined in ASTM C1177/C1177M.
 4. Core Type: Regular.
 5. Type X Thickness: 5/8 inch (16 mm).
 6. Regular Board Thickness: 1/2 inch (13 mm).
 7. Edges: Square.
 8. Glass Mat Faced Products:
 - a. American Gypsum Company; M-Glass Exterior Sheathing Type X: www.americangypsum.com.
 - b. CertainTeed Corporation; GlasRoc Type X Exterior Sheathing: www.certainteed.com.
 - c. USG Corporation; USG Securock Brand Ultralight Glass-Mat Sheathing Firecode X: www.usg.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

- G. Exterior Soffit Board: Exterior gypsum soffit board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Ceilings and soffits in protected exterior areas, unless otherwise indicated.
 - 2. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X.
 - 3. Types: Regular and Type X, in locations indicated.
 - 4. Type X Thickness: 5/8 inch (16 mm).
 - 5. Type C Thickness: 5/8 inch (16 mm).
 - 6. Regular Type Thickness: 1/2 inch (13 mm).
 - 7. Edges: Tapered.
 - 8. Products:
 - a. American Gypsum Company; Exterior Soffit Gypsum Wallboard Type X: www.americangypsum.com.
 - b. Georgia-Pacific Gypsum; ToughRock Fireguard C Soffit Board: www.gpgypsum.com.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 GYPSUM WALLBOARD ACCESSORIES

- A. Acoustic Insulation: See Section 07 21 00.
- B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
- C. Water-Resistive Barrier: See Section 07 25 00.
- D. Finishing Accessories: ASTM C1047, extruded aluminum alloy (6063 T5) or galvanized steel sheet ASTM A924/A924M G90, unless noted otherwise.
 - 1. Types: As detailed or required for finished appearance.
- E. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
- F. High Build Drywall Surfer: Vinyl acrylic latex-based coating for spray application, designed to take the place of skim coating and separate paint primer in achieving Level 5 finish.
- G. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches (0.84 mm) in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.
- H. Nails for Attachment to Wood Members: ASTM C514.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

3.2 FRAMING INSTALLATION

- A. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
 - 1. Level ceiling system to a tolerance of 1/1200.
 - 2. Laterally brace entire suspension system.
 - 3. Install bracing as required at exterior locations to resist wind uplift.
- B. Studs: Space studs at 16 inches on center (at 406 mm on center).
 - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 - 2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
 - 3. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.

- C. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.

3.3 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Acoustic Sealant: Install in accordance with manufacturer's instructions.

3.4 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Exterior Sheathing: Comply with ASTM C1280. Install sheathing vertically, with edges butted tight and ends occurring over firm bearing.
 - 1. Paper-Faced Sheathing: Immediately after installation, protect from weather by application of water-resistant barrier.
- C. Exterior Soffits: Install exterior soffit board perpendicular to framing, with staggered end joints over framing members or other solid backing.
- D. Installation on Wood Framing: For rated assemblies, comply with requirements of listing authority. For nonrated assemblies, install as follows:
 - 1. Single-Layer Applications: Screw attachment.

3.5 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
- B. Corner Beads: Install at external corners, using longest practical lengths.

3.6 JOINT TREATMENT

- A. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.
- B. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch (0.8 mm).
- C. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

3.7 TEXTURE FINISH

- A. Apply finish texture coating by means of spraying apparatus in accordance with manufacturer's instructions and to match approved sample.

3.8 TOLERANCES

- A. Not Applicable.

END OF SECTION 09 21 16



SECTION 09 22 36
LATH

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Metal lath for cement plaster.
- B. Furring for metal lath.

1.2 RELATED REQUIREMENTS

- A. Section 09 24 00 - Cement Plastering.

1.3 REFERENCE STANDARDS

- A. ASTM C841 - Standard Specification for Installation of Interior Lathing and Furring 2003 (Reapproved 2018).
- B. ASTM C847 - Standard Specification for Metal Lath 2018.
- C. ASTM C933 - Standard Specification for Welded Wire Lath 2018.
- D. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness 2018.
- E. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs 2020.
- F. ASTM C1032 - Standard Specification for Woven Wire Plaster Base 2018.
- G. ASTM C1063 - Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster 2021.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on furring and lathing components, structural characteristics, material limitations, and finish.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section with at least three years of documented experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Metal Lath and Accessories:
 - 1. Alabama Metal Industries Corporation; Self-Furred Diamond Mesh Lath: www.amico-lath.com.
 - 2. CEMCO: www.cemcosteel.com.
 - 3. ClarkDietrich: www.clarkdietrich.com.
 - 4. Structa Wire Corporation; Structa Mega Lath: www.structawire.com.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 FRAMING AND LATH ASSEMBLIES

- A. Provide completed assemblies with the following characteristics:
 - 1. Maximum Deflection of Vertical Assemblies: 1:360 under lateral point load of 100 lbs (445 N).
 - 2. Maximum Deflection of Horizontal Assemblies: 1:240 deflection under dead loads and wind uplift.

2.3 FRAMING MATERIALS

- A. Furring Channels: Formed steel, minimum 0.020 inch (0.5 mm) thick, 3/8 inch (10 mm) deep by 7/8 inch (22 mm) high, splicing permitted; galvanized.

2.4 LATH

- A. Diamond Mesh Metal Lath: ASTM C847, galvanized; self-furring.
 - 1. Weight: To suit application and as specified in ASTM C841 or ASTM C1063 for framing spacing.
 - 2. Backed with treated paper.
- B. Flat Rib Metal Lath: ASTM C847, galvanized; 1/8 inch (3 mm) thick.
 - 1. Weight: To suit application and as specified in ASTM C841 or ASTM C1063 for framing spacing.
 - 2. Backed with treated paper.
- C. Ribbed Metal Lath: ASTM C847, galvanized; 3/8 inch (9 mm) thick.
 - 1. Weight: To suit application and as specified in ASTM C841 or ASTM C1063 for framing spacing.
 - 2. Backed with treated paper.
- D. Welded Wire Lath: ASTM C933; galvanized; with 2 inch square (50 mm square) openings, paper strips woven into lath, of weight to suit application and as specified in ASTM C841 or ASTM C1063 for framing spacing.
- E. Woven Wire Mesh: ASTM C1032; galvanized; with 1 inch hexagonal (25 mm) openings; self-furring, of weight to suit application and as specified in ASTM C841 or ASTM C1063 for framing spacing.
- F. Beads, Screeds, Joint Accessories, and Other Trim: Depth governed by plaster thickness, and maximum possible lengths.
 - 1. Material: Formed sheet steel with rust inhibitive primer, expanded metal flanges.
 - 2. Casing Beads with Weep Holes: Square edges.
 - a. Products:
 - 1) Alabama Metal Industries Corporation; E-Z Bead: www.amicoglobal.com.
 - 2) Phillips Manufacturing Co; #66 Expanded Flange Square Casing Bead: www.phillipsmfg.com.
 - 3) Substitutions: See Section 01 60 00 - Product Requirements.
 - 3. Corner Beads: Radiused corners.
 - a. Products:
 - 1) Phillips Manufacturing Co; #1 Expanded Corner Bead: www.phillipsmfg.com.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
 - 4. Expansion Joints: Accordion profile with factory-installed protective tape, 2 inch (50 mm) wide flanges.
 - a. Products:
 - 1) Phillips Manufacturing Co; #15 Double V Expansion Joint: www.phillipsmfg.com.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.

2.5 ACCESSORIES

- A. Anchorage: Tie wire, nails, and other metal supports, of type and size to suit application; to rigidly secure materials in place, galvanized.
- B. Fasteners: Self-piercing tapping screws; ASTM C1002 or ASTM C954.
- C. Tie Wire: Annealed galvanized steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that substrates are ready to receive work and conditions are suitable for application.
- C. Do not begin until unacceptable conditions have been corrected.
- D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 INSTALLATION - GENERAL

- A. Install interior lath and furring for gypsum plaster in accordance with ASTM C841.

- B. Install metal lath and furring for Portland cement plaster in accordance with ASTM C1063.

3.3 CONTROL AND EXPANSION JOINT INSTALLATION

- A. Locate joints as indicated on drawings and comply with ASTM C1063.
 - 1. Area of plaster panel not to exceed 144 sq ft (13.4 sq m) for vertical surfaces.
 - 2. Area of plaster panel not to exceed 100 sq ft (9.3 sq m) for horizontal, curved or angled surfaces.
 - 3. Spacing between control joints not to exceed 18 ft (5.5 m) in each direction.
 - 4. Area bounded by control joints not to exceed a length-to-width ratio of 2-1/2 to 1.

3.4 LATH INSTALLATION

- A. Apply lath taut, with long dimension perpendicular to supports.
- B. Lap or nest ends of metal lath in accordance with ASTM C841.
- C. Secure end laps with tie wire where they occur between supports.
- D. Continuously reinforce internal angles with corner mesh, except where the metal lath returns 3 inches (75 mm) from corner to form the angle reinforcement; fasten at perimeter edges only.
- E. Place corner bead at external wall corners; fasten at outer edges of lath only.
- F. Place base screeds at termination of plaster areas; secure rigidly in place.
- G. Place lath vertically above each top corner and each side of door frames to 6 inches (150 mm) above ceiling line.
- H. Place casing beads at terminations of plaster finish. Butt and align ends. Secure rigidly in place.
- I. Place additional strip mesh diagonally at corners of lathed openings. Secure rigidly in place.

3.5 TOLERANCES

- A. Maximum Variation from True Lines and Levels: 1/8 inch in 10 feet (3 mm in 3 m).
- B. Maximum Variation from True Position: 1/8 inch (3 mm).

END OF SECTION 09 22 36

**SECTION 09 24 00
CEMENT PLASTERING**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cement plastering.

1.2 RELATED REQUIREMENTS

- A. Section 09 22 36 - Lath: Lath, furring, beads, screeds, and joint accessories for plaster base.

1.3 REFERENCE STANDARDS

- A. ASTM C150/C150M - Standard Specification for Portland Cement 2021.
- B. ASTM C206 - Standard Specification for Finishing Hydrated Lime 2014.
- C. ASTM C897 - Standard Specification for Aggregate for Job-Mixed Portland Cement-Based Plasters 2015 (Reapproved 2020).
- D. ASTM C926 - Standard Specification for Application of Portland Cement-Based Plaster 2021.
- E. ASTM C932 - Standard Specification for Surface-Applied Bonding Compounds for Exterior Plastering 2006 (Reapproved 2019).

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide data on plaster materials and trim accessories.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.

1.6 FIELD CONDITIONS

- A. Do not apply plaster when substrate or ambient air temperature is under 50 degrees F or over 80 degrees F.
- B. Maintain minimum ambient temperature of 50 degrees F during installation of plaster and until cured.

PART 2 - PRODUCTS

2.1 CEMENT PLASTER APPLICATIONS

- A. Lath Plaster Base: Metal lath.
 - 1. Plaster Type: Jobsite mixed plaster.
 - 2. Number of Coats: Three.
 - 3. First Coat: Apply to a nominal thickness of 3/8 inch (9 mm).
 - 4. Second Coat: Apply to a nominal thickness of 3/8 inch (9 mm).
 - 5. Finish Coat: Apply to a nominal thickness of 1/8 inch (3 mm).

2.2 JOBSITE MIXED CEMENT PLASTER

- A. Materials:
 - 1. Portland Cement: ASTM C150/C150M, Type I.
 - 2. Lime: ASTM C206 Type S.
 - 3. Sand: Clean, well graded, and complying with ASTM C897.
 - 4. Water: Clean, fresh, potable, and free of mineral or organic matter that could adversely affect plaster.
- B. Plaster Mixes: Proportioned in accordance with ASTM C926; parts by volume.
 - 1. First Coat Over Lath:
 - a. Minimum 2-1/2 parts and maximum 4 parts sand, per total volume of cementitious materials.
 - b. Provide fiber reinforcement at 1-1/2 lbs (0.7 kg) per sack of cement.

2. First Coat Over High Absorption Solid Base:
 - a. Minimum 2-1/2 parts and maximum 4 parts sand, per total volume of cementitious materials.
 - b. Fiber reinforcement at 1-1/2 lbs (0.7 kg) per sack of cement.
3. First Coat Over Low Absorption Solid Base:
 - a. Minimum 2-1/2 parts and maximum 4 parts sand, per total volume of cementitious materials.
 - b. Fiber reinforcement at 1-1/2 lbs (0.7 kg) per sack of cement.
4. Second Coat: Same mixture as first coat, without fiber reinforcement, except minimum 3 parts and maximum 5 parts sand.
5. Finish Coat:
 - a. Minimum 1-1/2 parts and maximum 3 parts sand, per total volume of cementitious materials.

2.3 ACCESSORIES

- A. Lath: See Section 09 22 36.
- B. Finishing Accessories: See Section 09 22 36.
- C. Bonding Compound: Provide type recommended for bonding plaster to solid surfaces, complying with ASTM C932.
- D. Reinforcing Mesh: 4.5 oz/sq yd (153 g/sq m) alkali-resistant mesh.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions are acceptable prior to starting this work.
- B. Verify lath is flat, secured to substrate, and joint and surface perimeter accessories are properly in place.

3.2 PREPARATION

- A. Roughen smooth concrete surfaces and apply bonding compound in accordance with manufacturer's written installation instructions.

3.3 INSTALLATION - WATER-RESISTIVE BARRIER

- A. Where cement plaster is installed as part of a barrier wall system, install two layers of water-resistive barrier in accordance with water-resistive barrier manufacturer's instructions.
- B. Integrate water-resistive barrier with flashing accessories, and adjacent doors, windows, penetrations, and cladding transitions.
- C. Apply water-resistive barrier horizontally with upper layer lapped over lower layer at least 2 inches (51 mm).
- D. Lap water-resistive barrier at least 6 inches (152 mm) at vertical joints.
- E. Lap water-resistive barrier at least 16 inches (406 mm) beyond vertical line of inside and outside corners in both directions.

3.4 MIXING

- A. Mix only as much plaster as can be used prior to initial set.
- B. Mix materials dry, to uniform color and consistency, before adding water.
- C. Do not retemper mixes after initial set has occurred.
- D. Protect mixtures from frost or freezing temperatures, contamination, and excessive evaporation.

3.5 APPLICATION

- A. Apply plaster in accordance with manufacturer's written instructions and comply with ASTM C926.
- B. Base Coats:
 1. Apply base coat(s) to fully embed lath and to specified thickness.



2. Follow guidelines in ASTM C926 and manufacturer's written installation instructions for moist curing base coats and application of subsequent coats.
- C. Leveling Coat:
 1. Apply leveling coat to specified thickness.
 2. Fully embed reinforcing mesh in leveling coat.
- D. Finish Coats:
 1. Cement Plaster:
 - a. Apply with sufficient material and pressure to ensure complete coverage of base to specified thickness.
 - b. Apply desired surface texture while mix is still workable.
 - c. Float to a consistent finish.

3.6 TOLERANCES

- A. Maximum Variation from True Flatness: 1/4 inch in 10 feet (6 mm in 3 m).

3.7 REPAIR

- A. Patching: Remove loose, damaged or defective plaster and replace with plaster of same composition; finish to match surrounding area.

END OF SECTION 09 24 00

**SECTION 09 30 00
TILING**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Tile for floor applications.
- B. Tile for wall applications.
- C. Cementitious backer board as tile substrate.
- D. Non-ceramic trim.

1.2 REFERENCE STANDARDS

- A. ANSI A108.1a - American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar 2017.
- B. ANSI A108.1b - American National Standard Specifications for Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar 2017.
- C. ANSI A108.1c - Contractor's Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar 1999 (Reaffirmed 2021).
- D. ANSI A108.2 - American National Standard General Requirements: Materials, Environmental and Workmanship 2019.
- E. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile-Setting Epoxy Adhesive 2019.
- F. ANSI A108.5 - American National Standard Specifications for Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar 2020.
- G. ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy 1999 (Reaffirmed 2019).
- H. ANSI A108.8 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout 1999 (Reaffirmed 2019).
- I. ANSI A108.9 - American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout 1999 (Reaffirmed 2019).
- J. ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework 2017.
- K. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units 2018.
- L. ANSI A108.12 - American National Standard for Installation of Ceramic Tile with EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar 1999 (Reaffirmed 2019).
- M. ANSI A108.13 - American National Standard for Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone 2005 (Reaffirmed 2021).
- N. ANSI A108.19 - American National Standard Specifications for Interior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs by the Thin-Bed Method Bonded with Modified Dry-Set Cement Mortar or Improved Modified Dry-Set Cement Mortar 2020.
- O. ANSI A118.3 - American National Standard Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive 2013 (Revised).
- P. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units 1999 (Reaffirmed 2016).
- Q. ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation 2014.
- R. ANSI A137.1 - American National Standard Specifications for Ceramic Tile 2021.

- S. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation 2019.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- C. Samples: Mount tile and apply grout on two plywood panels, minimum 18 by 18 inches (457 by 457 mm) in size illustrating pattern, color variations, and grout joint size variations.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.

PART 2 - PRODUCTS

2.1 TILE

- A. Manufacturers: All products by the same manufacturer.
 - 1. American Olean Corporation: www.americanolean.com.
 - 2. Dal-Tile Corporation: www.daltile.com.
 - 3. Emser Tile, LLC: www.emser.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Porcelain Wall Tile: ANSI A137.1 standard grade.
 - 1. Products:
 - a. See Finish Schedule.
- C. Porcelain Floor Tile: ANSI A137.1, and as follows:
 - 1. Ceramic Tile Flooring shall be stable, firm, and slip resistant (Flooring shall have a minimum Coefficient of Friction of 0.6, typical). CBC Section 11B-302.1.
 - 2. Products:
 - a. See Finish Schedule.

2.2 TRIM AND ACCESSORIES

- A. Non-Ceramic Trim: Brushed stainless steel, style and dimensions to suit application, for setting using tile mortar or adhesive.
 - 1. Manufacturers:
 - a. Schluter-Systems: www.schluter.com.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 SETTING MATERIALS

- A. Provide setting and grout materials from same manufacturer.
- B. Epoxy Adhesive and Mortar Bond Coat: ANSI A118.3.
 - 1. Products:
 - a. Custom Building Products; EBM-Lite Epoxy Bonding Mortar: www.custombuildingproducts.com.
 - b. LATICRETE International, Inc; LATICRETE LATAPOXY 300 Adhesive: www.laticrete.com.
 - c. Sika Corp; SikaTile 350 Flex Set: www.sika.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

2.4 GROUTS

- A. Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.
 - 1. Applications: Where indicated.

2. Color(s): As selected by Architect from manufacturer's full line.
3. Products:
 - a. ARDEX Engineered Cements; ARDEX WA: www.ardexamericas.com.
 - b. Custom Building Products; CEG-IG 100% Solids Industrial Grade Epoxy Grout: www.custombuildingproducts.com.
 - c. LATICRETE International, Inc; LATICRETE SPECTRALOCK PRO Premium Grout: www.laticrete.com.
 - d. Sika Corp; SikaTile 825 Epoxy: www.sika.com.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.

2.5 MAINTENANCE MATERIALS

- A. Tile Sealant: Gunnable, silicone, siliconized acrylic, or urethane sealant; moisture and mildew resistant type.
 1. Applications: Between tile and plumbing fixtures.
 2. Products:
 - a. ARDEX Engineered Cements; ARDEX SX: www.ardexamericas.com.
 - b. Custom Building Products; Commercial 100% Silicone Caulk: www.custombuildingproducts.com.
 - c. LATICRETE International, Inc; LATICRETE LATASIL: www.laticrete.com.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Grout Sealer: Liquid-applied, moisture and stain protection for existing or new Portland cement grout.
 1. Composition: Water-based colorless silicone.
 2. Products:
 - a. Merkrete, by Parex USA, Inc; Merkrete Revive: www.merkrete.com.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.6 ACCESSORY MATERIALS

- A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12; not intended as waterproofing.
 1. Crack Resistance: No failure at 1/16 inch (1.6 mm) gap, minimum.
 2. Fluid or Trowel Applied Type:
 - a. Material: Synthetic rubber or Acrylic.
 - b. Thickness: 20 mils (0.5 mm), maximum.
 - c. Products:
 - 1) H.B. Fuller Construction Products, Inc; TEC HydraFlex Waterproofing Crack Isolation Membrane: www.tecspecialty.com.
 - 2) LATICRETE International, Inc; LATICRETE Blue 92 Anti-Fracture Membrane: www.laticrete.com.
 - 3) Sika Corp; SikaTile 200 Fracture Guard Rapid: www.sika.com.
 - 4) Substitutions: See Section 01 60 00 - Product Requirements.
- B. Backer Board: Cementitious type complying with ANSI A118.9; high density, glass fiber reinforced, 7/16 inch (11 mm) thick; 2 inch (51 mm) wide coated glass fiber tape for joints and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subfloor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.

3.2 PREPARATION

- A. Protect surrounding work from damage.

- B. Vacuum clean surfaces and damp clean.
- C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.
- D. Install backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of setting material to a feather edge.
- E. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.3 INSTALLATION - GENERAL

- A. Install tile, thresholds, and stair treads and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.19 , manufacturer's instructions, and TCNA (HB) recommendations.
- B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
- C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
- E. Form internal angles square and external angles bullnosed.
- F. Install non-ceramic trim in accordance with manufacturer's instructions.
- G. Sound tile after setting. Replace hollow sounding units.
- H. Keep control and expansion joints free of mortar, grout, and adhesive.
- I. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- J. Grout tile joints unless otherwise indicated. Use standard grout unless otherwise indicated.
- K. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

3.4 INSTALLATION - FLOORS - THIN-SET METHODS

- A. Over exterior concrete substrates, install in accordance with TCNA (HB) Method F102, with standard grout.
- B. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, dry-set or latex-Portland cement bond coat, with standard grout, unless otherwise indicated.
 - 1. Where waterproofing membrane is indicated, install in accordance with TCNA (HB) Method F122, with latex-Portland cement grout.
 - 2. Where epoxy bond coat and grout are indicated, install in accordance with TCNA (HB) Method F131.
- C. Over wood substrates, install in accordance with TCNA (HB) Method F142, with standard grout, unless otherwise indicated.
 - 1. Where epoxy bond coat and grout are indicated, install in accordance with TCNA (HB) Method F143.

3.5 INSTALLATION - FLOORS - MORTAR BED METHODS

- A. Over exterior concrete substrates, install in accordance with TCNA (HB) Method F101, bonded, with standard grout.
- B. Over interior concrete substrates, install in accordance with TCNA (HB) Method F111, with cleavage membrane, unless otherwise indicated.
 - 1. Where waterproofing membrane is indicated, with standard grout or no mention of grout type, install in accordance with TCNA (HB) Method F121.
 - 2. Where epoxy bond coat and grout are indicated, install in accordance with TCNA (HB) Method F132, bonded.



- C. Over wood substrates, install in accordance with TCNA (HB) Method F141, with standard grout, unless otherwise indicated.
- D. Cleavage Membrane: Lap edges and ends.
- E. Mortar Bed Thickness: 5/8 inch (15.9 mm), unless otherwise indicated.

3.6 INSTALLATION - WALL TILE

- A. On exterior walls install in accordance with TCNA (HB) Method W244, thin-set over cementitious backer units, with waterproofing membrane.
- B. Over cementitious backer units on studs, install in accordance with TCNA (HB) Method W244, using membrane at toilet rooms.

3.7 CLEANING

- A. Clean tile and grout surfaces.

3.8 PROTECTION

- A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION 09 30 00

SECTION 09 51 00
ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.

1.2 REFERENCE STANDARDS

- A. ASTM C635/C635M - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings 2017.
- B. ASTM E1264 - Standard Classification for Acoustical Ceiling Products 2019.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on suspension system components and acoustical units.
- C. Manufacturer's Qualification Statement.

1.4 QUALITY ASSURANCE

- A. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.5 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F (16 degrees C), and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acoustic Tiles/Panels:
 - 1. Armstrong World Industries, Inc: www.armstrongceilings.com.
 - 2. Substitutions: "Armstrong World Industries, Inc." is a Board of Trustees Approved Sole Source Item. No substitutions will be accepted.
- B. Suspension Systems:
 - 1. Armstrong World Industries, Inc: www.armstrongceilings.com.
 - 2. Substitutions: "Armstrong World Industries, Inc." is a Board of Trustees Approved Sole Source Item. No substitutions will be accepted.

2.2 ACOUSTICAL UNITS

- A. Acoustical Units - General: ASTM E1264, Class A.
- B. Acoustical Panels: Painted mineral fiber, with the following characteristics:
 - 1. Classification: ASTM E1264 Type III.
 - 2. Size: 24 by 24 inches (610 by 610 mm).
 - 3. Thickness: 3/4 inch (19 mm).
 - 4. Panel Edge: Tegular.
 - 5. Color: White.
 - 6. Suspension System: Exposed grid.
 - 7. Products:
 - a. Armstrong World Industries, Inc [Armstrong #1912 Ultima](http://www.armstrongceilings.com): www.armstrongceilings.com.

2.3 SUSPENSION SYSTEM(S)

- A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
- B. Exposed Suspension System: Hot-dipped galvanized steel grid and cap.
 - 1. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
 - 2. Profile: Tee; 9/16 inch (14 mm) face width.
 - 3. Finish: Baked enamel.
 - 4. Color: White.
 - 5. Products:
 - a. Armstrong World Industries, Inc., [Suprafine XL](http://www.armstrongceilings.com); www.armstrongceilings.com.

2.4 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B. Hanger Wire: 12 gauge, 0.08 inch (2 mm) galvanized steel wire.
- C. Perimeter Moldings: Same metal and finish as grid.
 - 1. Size: As required for installation conditions and specified Seismic Design Category.
 - 2. Angle Molding: L-shaped, for mounting at same elevation as face of grid.
 - 3. Shadow Molding: Shaped to create a perimeter reveal.
 - 4. Acoustical Sealant For Perimeter Moldings: Non-hardening, non-skinning, for use in conjunction with suspended ceiling system.
- D. Touch-up Paint: Type and color to match acoustical and grid units.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.2 PREPARATION

- A. Install after major above-ceiling work is complete.
- B. Coordinate the location of hangers with other work.

3.3 INSTALLATION - SUSPENSION SYSTEM

- A. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- B. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Use longest practical lengths.
- C. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- D. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- E. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- F. Support fixture loads using supplementary hangers located within 6 inches (152 mm) of each corner, or support components independently.
- G. Do not eccentrically load system or induce rotation of runners.



3.4 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Fit border trim neatly against abutting surfaces.
- D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- E. Cutting Acoustical Units:
 - 1. Make field cut edges of same profile as factory edges.

3.5 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

END OF SECTION 09 51 00

**SECTION 09 65 00
RESILIENT FLOORING**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Resilient sheet flooring.
- B. Resilient tile flooring.
- C. Resilient base.
- D. Installation accessories.

1.2 RELATED REQUIREMENTS

- A. Section 09 05 61 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Grounding and bonding of static control flooring to building grounding system.

1.3 REFERENCE STANDARDS

- A. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source 2019a, with Editorial Revision (2020).
- B. ASTM F1066 - Standard Specification for Vinyl Composition Floor Tile 2004 (Reapproved 2018).
- C. ASTM F1700 - Standard Specification for Solid Vinyl Floor Tile 2020.
- D. ASTM F1861 - Standard Specification for Resilient Wall Base 2021.
- E. ASTM F1913 - Standard Specification for Vinyl Sheet Floor Covering Without Backing 2019.
- F. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source 2019.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Verification Samples: Submit two samples, 6 by 6 inch in size illustrating color and pattern for each resilient flooring product specified.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in installing specified flooring with minimum three years documented experience.
- C. Testing Agency Qualifications: Independent firm specializing in performing concrete slab moisture testing and inspections of the type specified in this section.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
- B. Store all materials off of the floor in an acclimatized, weather-tight space.
- C. Maintain temperature in storage area between 55 degrees F (13 degrees C) and 90 degrees F (72 degrees C).
- D. Protect roll materials from damage by storing on end.

1.7 FIELD CONDITIONS

- A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F (21 degrees C) to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F (13 degrees C).

PART 2 - PRODUCTS

2.1 SHEET FLOORING

- A. Vinyl Sheet Flooring: Homogeneous without backing, with color and pattern throughout full thickness.
 - 1. Resilient Flooring shall be stable, firm, and slip resistant (Flooring shall have a minimum Coefficient of Friction of 0.6, typical). CBC Section 11B-302.1.
 - 2. Minimum Requirements: Comply with ASTM F1913.
 - 3. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 - 4. Thickness: 0.080 inch (2.0 mm) nominal.
 - 5. Seams: Heat welded.
 - 6. Integral coved base with cap strip.
 - 7. Color: To be selected by Architect from manufacturer's full range.
- B. Welding Rod: Solid bead in material compatible with flooring, produced by flooring manufacturer for heat welding seams, and in color matching field color.
- C. Vinyl Welding Rod: Solid vinyl bead produced by manufacturer of vinyl flooring for heat welding seams, in color matching field color.

2.2 TILE FLOORING

- A. Vinyl Composition Tile: Homogeneous, with color extending throughout thickness.
 - 1. Minimum Requirements: Comply with ASTM F1066, of Class corresponding to type specified.
 - 2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 - 3. Size: 12 by 12 inch (305 by 305 mm).
 - 4. Thickness: 0.125 inch (3.2 mm).
 - 5. Color: To be selected by Architect from manufacturer's full range.
- B. Vinyl Tile: Solid vinyl with color and pattern throughout thickness.
 - 1. Minimum Requirements: Comply with ASTM F1700, of Class corresponding to type specified.
 - 2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 - 3. Total Thickness: 0.125 inch (3 mm).
 - 4. Color: To be selected by Architect from manufacturer's full range.

2.3 RESILIENT BASE

- A. Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; style as scheduled.
 - 1. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 - 2. Height: 4 inch (100 mm).
 - 3. Thickness: 0.125 inch (3.2 mm).
 - 4. Finish: Satin.
 - 5. Color: To be selected by Architect from manufacturer's full range.
 - 6. Accessories: Premolded external corners and internal corners.

2.4 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.
- B. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.
- C. Filler for Coved Base: Plastic.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
- C. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
 - 1. Test in accordance with Section 09 05 61.
 - 2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

3.2 PREPARATION

- A. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor filler to achieve smooth, flat, hard surface.
- B. Prohibit traffic until filler is fully cured.
- C. Clean substrate.

3.3 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install in accordance with manufacturer's written instructions.
- C. Adhesive-Applied Installation:
 - 1. Place copper grounding strip in conductive adhesive and apply additional adhesive to top side of strip before installing static control flooring. Allow strip to extend beyond flooring in accordance with static control flooring manufacturer's instructions. Refer to Section 26 0526 for grounding and bonding to building grounding system.
 - 2. Fit joints and butt seams tightly.
 - 3. Set flooring in place, press with heavy roller to attain full adhesion.

3.4 INSTALLATION - SHEET FLOORING

- A. Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns at seams.
- B. Seal seams by heat welding where indicated.
- C. Coved Base: Install as detailed on drawings, using coved base filler as backing at floor to wall junction. Extend sheet flooring vertically to height indicated, and cover top edge with metal cap strip.

3.5 INSTALLATION - TILE FLOORING

- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.

3.6 INSTALLATION - RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches (45 mm) between joints.
- B. Install base on solid backing. Bond tightly to wall and floor surfaces.

3.7 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION 09 65 00



**SECTION 09 68 00
CARPETING**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Carpet, direct-glued.
- B. Accessories.

1.2 REFERENCE STANDARDS

- A. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; current edition.
- B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; current edition.
- C. CRI 104 - Standard for Installation of Commercial Carpet; current edition.
- D. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; current edition.

1.3 SUBMITTALS

- A. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- B. Samples: Submit two samples 24 x 24 inch in size illustrating color and pattern for each carpet and cushion material specified.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in installing carpet with minimum three years documented experience.

1.5 FIELD CONDITIONS

- A. Store materials in area of installation for minimum period of 24 hours prior to installation.
- B. Maintain minimum 70 degrees F ambient temperature 24 hours prior to, during and 24 hours after installation.

PART 2 - PRODUCTS

2.1 CARPET

- A. Carpet:
 - 1. Product: "Scena" - 12' Broadloom; color: "3411 St. Croix" manufactured by Mannington.
 - 2. Carpet shall be securely attached and shall have a firm cushion, pad, or backing or no cushion or pad. It shall have a level loop, textured loop, level cut pile, or level cut/uncut pile texture. Pile height shall be 1/2" maximum.
 - 3. Exposed edges shall be fastened to floor surfaces and shall have trim on the entire length. Carpet edges shall comply with CBC requirements.
 - 4. Flooring Radiant Panel: Class 1 (mean average CRF: 0.45 watts/sq cm or higher) when tested in accordance with ASTM E648 or NFPA 253.
 - 5. Smoke Generation: Less than 450 (ASTM E-662)
- B. Walk Off:
 - 1. Product: "Recoarse II"; color "3517 Boulevard Blue" manufactured by Mannington.

2.2 CUSHION

- A. Cushion: Cellular rubberDouble bond rubber carpet pad.
 - 1. Product: Ultrabac RE manufactured by Mannington.



2.3 ACCESSORIES

- A. Sub-Floor Filler: Type recommended by carpet manufacturer.
- B. Base: 4 inch, rubber type, smooth finish, color as selected from manufacturer's standards.
- C. Seam Adhesive: Recommended by carpet manufacturer.
- D. Carpet Adhesive: Recommended by carpet manufacturer; releasable type.
- E. Walk Off shall be installed on the inside of each exterior door with carpet condition using "T"-shaped rubber molding transition.

END OF SECTION 09 68 00

**SECTION 09 36 13
TILE CARPETING**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Carpet, direct-glued.
- B. Accessories.

1.2 REFERENCE STANDARDS

- A. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; current edition.
- B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; current edition.
- C. CRI 104 - Standard for Installation of Commercial Carpet; current edition.
- D. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; current edition.

1.3 SUBMITTALS

- A. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- B. Samples: Submit two samples 24 x 24 inch in size illustrating color and pattern for each carpet specified.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in installing carpet with minimum three years documented experience.

1.5 FIELD CONDITIONS

- A. Store materials in area of installation for minimum period of 24 hours prior to installation.
- B. Maintain minimum 70 degrees F ambient temperature 24 hours prior to, during and 24 hours after installation.

PART 2 - PRODUCTS

2.1 CARPET

- A. Carpet:
 - 1. Product: "Scena – Infinity Modular"; size: 24"x24"; color: "3411 St. Croix" manufactured by Mannington.
 - 2. Carpet shall be securely attached. It shall have a patterned loop. Pile height shall be 0.118" thick.
 - 3. Flooring Radiant Panel: Class 1 (mean average CRF: 0.45 watts/sq cm or higher) when tested in accordance with ASTM E648 or NFPA 253.
 - 4. Smoke Generation: Less than 450 (ASTM E-662)
- B. Walk Off:
 - 1. Product: "Recoarse II"; color "3517 Boulevard Blue" manufactured by Mannington.

2.2 ACCESSORIES

- A. Sub-Floor Filler: Type recommended by carpet manufacturer.
- B. Base: 4 inch, rubber type, smooth finish, color as selected from manufacturer's standards.
- C. Carpet Adhesive: Recommended by carpet manufacturer; releasable type.
- D. Walk off mat shall be installed on the inside of each exterior door with carpet condition using "T"-shaped rubber molding transition.



END OF SECTION 09 68 13



SECTION 09 68 16
SHEET CARPETING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Carpet, direct-glued.
- B. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 09 05 61 - Common Work Results for Flooring Preparation: Independent agency testing of concrete slabs, removal of existing floor coverings, cleaning, and preparation.

1.3 REFERENCE STANDARDS

- A. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source 2019a, with Editorial Revision (2020).
- B. CRI 104 - Standard for Installation of Commercial Carpet 2015.
- C. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source 2019.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- C. Samples: Submit two samples 24 x 24 inch in size illustrating color and pattern for each carpet and cushion material specified.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in installing carpet with minimum three years documented experience.
- C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.6 FIELD CONDITIONS

- A. Store materials in area of installation for minimum period of 24 hours prior to installation.
- B. Maintain minimum 70 degrees F (21 degrees C) ambient temperature 24 hours prior to, during and 24 hours after installation.

PART 2 - PRODUCTS

2.1 CARPET

- A. Carpet:
 - 1. Product: "Scena" - 12' Broadloom; color: "3411 St. Croix" manufactured by Mannington.
 - 2. Carpet shall be securely attached and shall have a firm cushion, pad, or backing or no cushion or pad. It shall have a level loop, textured loop, level cut pile, or level cut/uncut pile texture. Pile height shall be 1/2" maximum.
 - 3. Exposed edges shall be fastened to floor surfaces and shall have trim on the entire length. Carpet edges shall comply with CBC requirements.
 - 4. Smoke Generation: Less than 450 (ASTM E-662).
 - 5. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.

- B. Entryway System:
 - 1. Product: "Recoarse II"; color "3517 Boulevard Blue" manufactured by Mannington.
 - 2. Entryway system shall be installed on the inside of each exterior door with carpet condition using "T"-shaped rubber molding transition.

2.2 CUSHION

- A. Cushion: Double bond rubber carpet pad.
 - 1. Product: Ultrabac RE manufactured by Mannington.

2.3 ACCESSORIES

- A. Subfloor Filler: Type recommended by carpet manufacturer.
- B. Tackless Strip: Carpet gripper, of type recommended by carpet manufacturer to suit application, with attachment devices.
- C. Seam Adhesive: Recommended by carpet manufacturer.
- D. Carpet Adhesive: Recommended by carpet manufacturer; releasable type.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subfloor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive carpet.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive carpet.
- C. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesives to subfloor surfaces.
- D. Cementitious Subfloor Surfaces: Verify that substrates are ready for flooring installation by testing for moisture and alkalinity (pH).
 - 1. Test in accordance with Section 09 05 61.
 - 2. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.

3.2 PREPARATION

- A. Prepare floor substrates for installation of flooring in accordance with Section 09 05 61.

3.3 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install carpet and cushion in accordance with manufacturer's instructions and CRI 104 (Commercial).
- C. Verify carpet match before cutting to ensure minimal variation between dye lots.
- D. Lay out carpet and locate seams in accordance with shop drawings.
 - 1. Locate seams in area of least traffic, out of areas of pivoting traffic, and parallel to main traffic.
 - 2. Do not locate seams perpendicular through door openings.
 - 3. Align run of pile in same direction as anticipated traffic and in same direction on adjacent pieces.
 - 4. Locate change of color or pattern between rooms under door centerline.
 - 5. Provide monolithic color, pattern, and texture match within any one area.
- E. Install carpet tight and flat on subfloor, well fastened at edges, with a uniform appearance.

3.4 STRETCHED-IN CARPET

- A. Install tackless strips with pins facing the wall around entire perimeter, except across door openings. Use edge strip where carpet terminates at other floor coverings.
- B. Space tackless strips slightly less than carpet thickness away from vertical surfaces, but not more than 3/8 inch (9 mm).
- C. Install cushion in maximum size pieces using spot adhesive to adhere to subfloor.



- D. Lay out cushion so that seams will be perpendicular to, or offset from, minimum 6 inches (150 mm) from carpet seams.
- E. Butt cushion edges together and tape seams.
- F. Trim cushion tight to edge of tackless strip and around projections and contours.
- G. Double cut carpet seams, with accurate pattern match. Make cuts straight, true, and unfrayed. Apply seam adhesive to all cut edges immediately.
- H. Join seams by hand sewing. Form seams straight, not overlapped or peaked, and free of gaps.
- I. Following seaming, hook carpet onto tackless strip at one edge, power stretch, and hook firmly at other edges. Follow manufacturer's recommendations for method and amount of stretch.
- J. Trim carpet neatly at walls and around interruptions. Tuck edges into space between tackless strip and wall.

3.5 DIRECT-GLUED CARPET

- A. Double cut carpet seams, with accurate pattern match. Make cuts straight, true, and unfrayed. Apply seam adhesive to cut edges of woven carpet immediately.
- B. Apply contact adhesive to floor uniformly at rate recommended by manufacturer. After sufficient open time, press carpet into adhesive.
- C. Apply seam adhesive to the base of the edge glued down. Lay adjoining piece with seam straight, not overlapped or peaked, and free of gaps.
- D. Roll with appropriate roller for complete contact of adhesive to carpet backing.
- E. Trim carpet neatly at walls and around interruptions.

3.6 CLEANING

- A. Remove excess adhesive from floor and wall surfaces without damage.
- B. Clean and vacuum carpet surfaces.

END OF SECTION 09 68 16

SECTION 09 84 00
ACOUSTIC ROOM COMPONENTS



PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fabric-covered fiberglass core panels and mounting accessories.

1.2 REFERENCE STANDARDS

- A. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method; current edition.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; current edition.
- C. ASTM E795 - Standard Practices for Mounting Test Specimens During Sound Absorption Tests; current edition.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's printed data sheets for products specified.
- B. Shop Drawings: Fabrication and installation details, panel layout, and fabric orientation.
- C. Selection Samples: Manufacturer's color charts for fabric covering, indicating full range of fabrics, colors, and patterns available.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company with not less than five years of experience in manufacturing acoustical products similar to those specified.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect acoustical panels from moisture during shipment, storage, and handling. Deliver in factory-wrapped bundles; do not open bundles until panels are needed for installation.
- B. Store panels flat, in dry, well-ventilated space; do not stand panels on end.
- C. Protect panel edges from damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Fabric-Covered Acoustical Panels:
 - 1. Basis of Design: Lamvin Sonic 1 Acoustical Wall Panels.

2.2 FABRIC-COVERED ACOUSTICAL PANELS

- A. Panels: Prefinished, factory assembled fabric-covered panels.
 - 1. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
- B. Fiberglass Core Panels:
 - 1. Density: 7 to 10 lb/cu ft.
 - 2. Noise Reduction Coefficient (NRC): 0.80 to 0.90 when tested in accordance with ASTM C423 for Type A mounting, per ASTM E795.
 - 3. Panel Width: As detailed -36 " typical.
 - 4. Panel Height: As detailed.
 - 5. Panel Thickness: 1 inch.
 - 6. Edges: Perimeter edges reinforced by a formulated resin hardener.
 - 7. Corners: Square.
 - 8. Mounting: Back mounting.
- C. Fabric Covering: Seamless fabric facing material, for stretched covering of core material.



1. Fabric: Manufacturer's standard.
2. Color: As selected from manufacturer's standard color offering.

2.3 FABRICATION

- A. Fabric Wrapped, General: Fabricate panels to sizes and configurations indicated, with fabric facing installed without sagging, wrinkles, blisters, or visible seams.
- B. Tolerances: Fabricate to finished tolerance of plus or minus 1/16 inch for thickness, overall length and width, and squareness from corner to corner.

2.4 ACCESSORIES

- A. Back-Mounting Accessories: Manufacturer's standard accessories for concealed support, designed to allow panel removal, and as follows:
 1. Hook and loop strips adhered to substrate and to back of panels.

PART 3 - EXECUTION

3.1 NOT APPLICABLE

END OF SECTION 09 84 00

SECTION 09 84 14
ACOUSTIC STRETCHED-FABRIC WALL AND CEILING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Acoustic stretched-fabric wall system.
- B. Accessories as required for complete installation.

1.2 REFERENCE STANDARDS

- A. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method; current edition.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; current edition.
- C. ASTM E795 - Standard Practices for Mounting Test Specimens During Sound Absorption Tests; current edition.
- D. ASTM E2573 - Standard Practice for Specimen Preparation and Mounting of Site-Fabricated Stretch Systems to Assess Surface Burning Characteristics; current edition.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Specimen warranty.
- B. Selection Samples: Fabric swatches representing manufacturer's full range of available colors, textures, and patterns.
- C. Verification Samples:
 - 1. For each fabric specified, minimum size 12 inch square, representing actual product in color, texture, and pattern.
- D. Warranty Documentation: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Firm specializing in acoustic stretched-fabric systems, with not less than 5 years of documented experience in installing systems of the type specified, and approved by the manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect fabric, acoustical backing, and track from excessive moisture in shipment, storage, and handling.
- B. Do not deliver materials to project until wet work such as concrete and plaster has been completed.
- C. Store products in manufacturer's unopened packaging until ready for installation.
- D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.6 WARRANTY

- A. Correct defective work within five year period after Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acoustic Stretched-Fabric Wall Systems:
 - 1. Basis of Design: Sonic 1 manufactured by Lamvin.



2.2 ACOUSTIC STRETCHED-FABRIC SYSTEM

- A. Acoustic Stretched-Fabric Wall System: Field installed, fabric is stretched and set into framework and laid over acoustic material anchored to substrate. Framework consists of continuous perimeter and intermediate mounting frames anchored to substrate, and designed to permit removal and replacement of fabric within framed areas without affecting adjacent areas.
 - 1. Surface Burning Characteristics: Flame Spread Index of 25, maximum; Smoke Developed Index of 450, maximum; when whole system is tested in accordance with ASTM E84 using mounting specified in ASTM E2573 for stretched systems.
 - 2. Noise Reduction Coefficient (NRC): 0.80, minimum, when tested in accordance with ASTM C423, Type A mounting per ASTM E795.

2.3 MATERIALS

- A. Frame: Extruded polymer framing system with serrated jaws of sufficient strength to hold fabric in place after repeated applications.
- B. Acoustic Material:
 - 1. Multi-Density Fiberglass Board: Consisting of 1/8 inch thick facing sheet of 18 to 22 lbs/cu ft density laminated over compressed fiberglass board, Class A fire rated in accordance with ASTM E84, with square edge in panel sizes per drawings.
 - a. Overall Thickness: 1 1/2 inch.
- C. Fabric:
 - 1. Manufacturer: Guilford of Maine.
- D. Fasteners: As recommended by manufacturer of acoustic stretched-fabric system in accordance with project requirements.

PART 3 - EXECUTION

3.1 NOT APPLICABLE

END OF SECTION 09 84 14

SECTION 09 91 13
EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints.
- C. Scope: Finish exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
- D. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
 - 5. Non-metallic roofing and flashing.
 - 6. Stainless steel, anodized aluminum, bronze, terne-coated stainless steel, zinc, and lead.
 - 7. Floors, unless specifically indicated.
 - 8. Glass.
 - 9. Concealed pipes, ducts, and conduits.

1.2 REFERENCE STANDARDS

- A. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials 2020.
- B. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual Current Edition.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
 - 2. MPI product number (e.g. MPI #47).
 - 3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum three years documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum three years experience and approved by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.6 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the paint product manufacturer's temperature ranges.



- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply exterior paint and finishes during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
- D. Provide lighting level of 80 ft candles (860 lx) measured mid-height at substrate surface.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.

2.2 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready-mixed, unless required to be a field-catalyzed paint.
 - 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is described explicitly in manufacturer's product instructions.
- B. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.
- C. Colors: To be selected from manufacturer's full range of available colors.
 - 1. Selection to be made by Architect after award of contract.
 - 2. Allow for minimum of three colors for each system, unless otherwise indicated, without additional cost to Owner.

2.3 PAINT SYSTEMS - EXTERIOR

- A. Paint E-OP - Exterior Surfaces to be Painted, Unless Otherwise Indicated: Including concrete, concrete masonry units, brick, fiber cement siding, primed wood, and primed metal.
 - 1. Two top coats and one coat primer.
- B. Paint WE-OP-3L - Wood, Opaque, Latex, 3 Coat:
 - 1. One coat of latex primer sealer.
 - 2. Semi-gloss: Two coats of latex enamel.
- C. Paint GE-OP-3L - Exterior Gypsum Board and Exterior Plaster, Opaque, Latex, 3 Coat:
 - 1. One coat of latex primer sealer.
 - 2. Flat: Two coats of latex.
- D. Paint ME-OP-2L - Ferrous Metals, Primed, Latex, 2 Coat:
 - 1. Touch-up with rust-inhibitive primer recommended by top coat manufacturer.
 - 2. Semi-gloss: Two coats of latex enamel.
- E. Paint E-Pav - Pavement Marking Paint:
 - 1. Yellow: One coat, with reflective particles.
 - 2. White: One coat, with reflective particles.

2.4 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin application of paints and finishes until substrates have been properly prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.
- D. Test shop-applied primer for compatibility with subsequent cover materials.
- E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Fiber Cement Siding: 12 percent.
 - 2. Masonry, Concrete, and Concrete Masonry Units: 12 percent.
 - 3. Exterior Wood: 15 percent, measured in accordance with ASTM D4442.

3.2 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces for finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- F. Concrete: Per Manufacturer
- G. Masonry: Per Manufacturer
- H. Fiber Cement Siding: Remove dirt, dust and other foreign matter with a stiff fiber brush. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
- I. Exterior Wood Surfaces to Receive Opaque Finish: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with tinted exterior calking compound after prime coat has been applied. Back prime concealed surfaces before installation.

3.3 APPLICATION

- A. Exterior Wood to Receive Opaque Finish: If final painting must be delayed more than 2 weeks after installation of woodwork, apply primer within 2 weeks and final coating within 4 weeks.
- B. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- C. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- D. Apply each coat to uniform appearance.
- E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- F. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.4 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.5 PROTECTION



- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 09 91 13

SECTION 09 91 23
INTERIOR PAINTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints.
- C. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
 - 1. Mechanical and Electrical:
 - a. In finished areas, paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
- D. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
 - 5. Floors, unless specifically indicated.
 - 6. Glass.
 - 7. Concealed pipes, ducts, and conduits.

1.2 REFERENCE STANDARDS

- A. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials 2020.
- B. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual Current Edition.
- C. SSPC-SP 1 - Solvent Cleaning 2015, with Editorial Revision (2016).
- D. SSPC-SP 6 - Commercial Blast Cleaning 2007.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
 - 2. MPI product number (e.g., MPI #47).
 - 3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
- C. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches (216 by 279 mm) in size, illustrating range of colors available for each finishing product specified.
 - 1. Where sheen is specified, submit samples in only that sheen.
- D. Certification: By manufacturer that paints and finishes comply with VOC limits specified.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum three years documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum three years experience and approved by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.6 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply materials when relative humidity exceeds 85 percent, at temperatures less than 5 degrees F (3 degrees C) above the dew point, or to damp or wet surfaces.
- D. Minimum Application Temperatures for Paints: 50 degrees F (10 degrees C) for interiors unless required otherwise by manufacturer's instructions.
- E. Provide lighting level of 80 ft candles (860 lx) measured mid-height at substrate surface.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.

2.2 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready-mixed, unless intended to be a field-catalyzed paint.
 - 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Colors: To be selected from manufacturer's full range of available colors.
 - 1. Selection to be made by Architect after award of contract.
 - 2. Allow for minimum of three colors for each system, unless otherwise indicated, without additional cost to Owner.
 - 3. Extend colors to surface edges; colors may change at any edge as directed by Architect.
 - 4. In finished areas, finish pipes, ducts, conduit, and equipment the same color as the wall/ceiling under which they are mounted.

2.3 PAINT SYSTEMS - INTERIOR

- A. Paint I-OP - Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board, concrete, concrete masonry units, brick, wood, plaster, uncoated steel, shop primed steel, galvanized steel, aluminum, and acoustical ceilings.
 - 1. Two top coats and one coat primer.
- B. Paint WI-OP-3L - Wood, Opaque, Latex, 3 Coat:
 - 1. One coat of latex primer sealer.
 - 2. Eggshell: Two coats of latex enamel.
- C. Paint CI-OP-3L - Concrete/Masonry, Opaque, Latex, 3 Coat:
 - 1. One coat of block filler.
 - 2. Semi-gloss: Two coats of latex enamel.
- D. Paint MI-OP-3L - Ferrous Metals, Unprimed, Latex, 3 Coat:

1. One coat of latex primer.
 2. Semi-gloss: Two coats of latex enamel.
- E. Paint MI-OP-2L - Ferrous Metals, Primed, Latex, 2 Coat:
1. Touch-up with latex primer.
 2. Semi-gloss: Two coats of latex enamel.
- F. Paint Mgl-OP-3L - Galvanized Metals, Latex, 3 Coat:
1. One coat galvanize primer.
 2. Semi-gloss: Two coats of latex enamel.
- G. Paint GI-OP-3L - Gypsum Board/Plaster, Latex, 3 Coat:
1. One coat of alkyd primer sealer.
 2. Eggshell: Two coats of latex enamel.
- H. Paint GI-OP-3LA - Gypsum Board/Plaster, Latex-Acrylic, 3 Coat:
1. One coat of alkyd primer sealer.
 2. Eggshell: Two coats of latex-acrylic enamel.

2.4 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin application of paints and finishes until substrates have been adequately prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- E. Test shop-applied primer for compatibility with subsequent cover materials.
- F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
 1. Gypsum Wallboard: 12 percent.
 2. Plaster and Stucco: 12 percent.
 3. Masonry, Concrete, and Concrete Masonry Units: 12 percent.
 4. Interior Wood: 15 percent, measured in accordance with ASTM D4442.

3.2 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or repair existing paints or finishes that exhibit surface defects.
- D. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- E. Seal surfaces that might cause bleed through or staining of topcoat.
- F. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
- G. Plaster: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.



- H. Aluminum: Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
- I. Galvanized Surfaces:
- J. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.
 - 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
 - 3. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 "Commercial Blast Cleaning". Protect from corrosion until coated.
- K. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.

3.3 APPLICATION

- A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- B. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- C. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- D. Apply each coat to uniform appearance in thicknesses specified by manufacturer.
- E. Sand wood and metal surfaces lightly between coats to achieve required finish.
- F. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- G. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.4 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.5 PROTECTION

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 09 91 23

SECTION 09 96 00
HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. High performance coatings.
- B. Surface preparation.

1.2 REFERENCE STANDARDS

- A. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association Current Edition.
- B. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual Current Edition.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide complete list of all products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
 - 2. MPI product number (e.g. MPI #47).
 - 3. Cross-reference to specified coating system(s) product is to be used in; include description of each system.
- C. Samples: Submit two samples 8 by 8 inch (203 by 203 mm) in size illustrating colors available for selection.
- D. Manufacturer's Certificate: Certify that high-performance coatings comply with VOC limits specified.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Coating Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.6 FIELD CONDITIONS

- A. Do not install materials when temperature is below 55 degrees F (13 degrees C) or above 90 degrees F (32 degrees C).
- B. Maintain this temperature range, 24 hours before, during, and 72 hours after installation of coating.
- C. Restrict traffic from area where coating is being applied or is curing.

1.7 WARRANTY

- A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.



PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Only materials (primers, coatings, etc.) listed in the latest edition of the MPI Approved Product List (APL) are acceptable for use on this project.
- B. Provide high performance coating products from the same manufacturer to the greatest extent possible.
- C. High-Performance Coatings:
 - 1. PPG Paints: www.ppgpaints.com.
 - 2. Sherwin-Williams Company: www.protective.sherwin-williams.com/industries.
 - 3. Tnemec Company, Inc: www.tnemec.com.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.

2.2 HIGH-PERFORMANCE COATINGS

- A. MPI Standards: Provide products that comply with MPI standards indicated and are listed in MPI Approved Products List.
- B. Provide coating systems that meet the following minimum performance criteria, unless more stringent criteria are specified:

2.3 TOP COAT MATERIALS

- A. Coatings - General: Provide complete multi-coat systems formulated and recommended by manufacturer for the applications indicated, in the thicknesses indicated; number of coats specified does not include primer or filler coat.
- B. Epoxy Coating:
 - 1. Number of coats: Two.
 - 2. Top Coat(s): Polyamide Epoxy; MPI #77, #177.
 - a. Sheen: Semi-Gloss.
 - b. Products:
 - 1) PPG Paints; Amerlock 400 High Solids Epoxy Coating, AK-400 Series, Semi-Gloss: www.ppgpaints.com.
 - 2) Sherwin-Williams; Macropoxy 646 Fast Cure Epoxy: www.protective.sherwin-williams.com. (MPI #177)
 - 3) Tnemec Company, Inc; Series 287 Enviro-Pox: www.tnemec.com.
 - 4) Substitutions: Section 01 60 00 - Product Requirements.
- C. Shellac: Pure, white type.

2.4 PRIMERS

- A. Primers: Provide the following unless other primer is required or recommended by coating manufacturer.
 - 1. Pre-Primer, Epoxy.
 - a. Products:
 - 1) PPG Paints; Amerlock Sealer AK-0A/AK-0B: www.ppgpaints.com.
 - 2) Substitutions: Section 01 60 00 - Product Requirements.

2.5 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of coated surfaces.

PART 3 - PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Do not begin application of coatings until substrates have been properly prepared.



- C. Verify that substrate surfaces are ready to receive work as instructed by the coating manufacturer. Obtain and follow manufacturer's instructions for examination and testing of substrates.
- D. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

3.2 PREPARATION

- A. Clean surfaces of loose foreign matter.
- B. Remove substances that would bleed through finished coatings. If unremovable, seal surface with shellac.
- C. Remove finish hardware, fixture covers, and accessories and store.
- D. Protect adjacent surfaces and materials not receiving coating from spatter and overspray; mask if necessary to provide adequate protection. Repair damage.

3.3 PRIMING

- A. Apply primer to all surfaces, unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.

3.4 COATING APPLICATION

- A. Apply coatings in accordance with manufacturer's written instructions, to thicknesses specified and recommendations in MPI - Architectural Painting and Specification Manual.
- B. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

3.5 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for general requirements for field inspection.

3.6 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.
- B. Clean surfaces immediately of overspray, splatter, and excess material.
- C. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.7 PROTECTION

- A. Protect finished work from damage.

END OF SECTION 09 96 00

SECTION 09 96 20
PERMANENT NON-SACRIFICIAL ANTI-GRAFFITI COATING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Anti-graffiti coating systems vertical surfaces for concrete unit masonry (painted and unpainted).
- B. Surface preparation
- C. field application

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING:

- A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 099000 - Painting and Coating.
- C. Section 033000 - Cast-in-Place Concrete; Building concrete
- D. Section 042000 - Unit Masonry; Concrete unit masonry construction.
- E. Section 079005 - Joint Sealers; Joint sealants.
- F. Section 323300 - Architectural Site Concrete

1.3 REGULATORY REQUIREMENTS

- A. California Air Resources Board, Volatile Organic Compound (VOC) Limitation: Provide anti-graffiti coating materials, including primers, undercoats, and finish-coat materials, that have a VOC content of 100 g/l or less, consistent with Southern California Air Quality Management District (SCAQMD) Rule 1113 for architectural flat coatings.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating coating materials and .
- C. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Maintenance Data: Include cleaning procedures and repair and patching techniques.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
- G. Extra Coating Materials: 1 gallon of each type and color.
- H. Label each container with manufacturer's name, product number, color number, and room names and numbers where used.

1.5 QUALITY ASSURANCE

- A. Maintain one copy of each referenced document that applies to application on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- C. Applicator Qualifications: Company specializing in performing the work of this section with minimum _____years documented experience.

1.6 MOCK-UP

- A. Apply Sealer and Anti-graffiti coating to approved Architectural Site Concrete Mock-ups for review and approval by Architect and client prior to beginning work.
- B. Locate where directed.
- C. Mock-up may remain as part of the Work.



1.7 FIELD CONDITIONS

- A. Do not install materials when temperature is below 55 degrees F or above 90 degrees F.
- B. Maintain this temperature range, 24 hours before, during, and 72 hours after installation of coating.
- C. Restrict traffic from area where coating is being applied or is curing.

1.8 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within one year period after Date of Substantial Completion.
- C. Warranty: Include coverage for bond to substrate.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Products: The design for each non-sacrificial anti-graffiti coating system is based on the products indicated.
- B. Type 2, Silane/Siloxane-Based Systems:
 - 1. Rainguard International Inc., VandlGuardTEN non-sacrificial Anti-Graffiti System.
 - a. Sealer; Product Micro-Seal Water Repellant.
 - b. Non-Sacrificial Coating; Product VandlGuardTEN
 - c. Finish Coat; Product VandlGuard Finish Coat.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Non-sacrificial anti-graffiti coating system with the following properties:
 - 1. Superior protection against, and easy removal of, unwanted graffiti.
 - 2. Minimum alteration of appearance of treated surface when compared to untreated surface, including gloss and color.
 - 3. Minimum alteration of water vapor transmission rate through complete wall system.
 - a. Coating system shall have a minimum water vapor transmission rate of 95 percent when tested per ASTM D1653.
- B. Completed coating system performance shall comply with ASTM D 6578 "Standard Practice for Determination of Graffiti Resistance," and the following:
 - 1. Cleanability Level 3: Achieve Level 3 cleaning performance, removing all test graffiti items using citrus-based cleaners or milder solvents.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions under which anti-graffiti coatings will be applied, for compliance with coating application requirements.
- B. Apply coatings only after unsatisfactory conditions have been corrected and surfaces to receive coatings are thoroughly dry.

3.2 PREPARATION

- A. General: Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item; provide surface-applied protection before surface preparation and coating.
 - 1. After completing coating operations, reinstall items that were removed, using workers skilled in the trades involved.
- B. Surface Preparation: Clean and prepare surfaces to be coated according to manufacturer's written instructions for each substrate condition and as specified.

1. Prepare concrete and unit masonry to be coated. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods to prepare surfaces.
 2. Surfaces to receive sealer shall be cleaned of dirt, oil, graffiti, grease, laitance, and other contaminants.
 3. Mid-pressure water (1500 psi) washing is the minimum cleaning that will be accepted, other methods, such as abrasive blasting and power may be submitted for review.
 4. Schedule cleaning and coating application so dust and other contaminants from cleaning process will not fall on wet, newly coated surfaces.
- C. Material Preparation: Carefully mix and prepare coating materials according to manufacturer's written instructions.
1. Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.
 2. Stir materials before applying to produce a mixture of uniform density. Stir as required during application.
 3. Do not stir surface film into the material. Remove film and, if necessary, strain coating material before using.
 4. Use only the type of thinners approved by manufacturer and only within recommended limits.
- D. Protect adjoining work, including sealant bond surfaces, from spillage or blow-over of coating system components. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of components being deposited on surfaces. Cover live plants and grass.
- E. Coordination with Sealants: Do not apply anti-graffiti coatings until sealants for joints adjacent to surfaces receiving coatings have been installed and cured.
1. Anti-graffiti coating work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, anti-graffiti coatings, and sealant materials identical to those used in the work.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 APPLICATION

- A. General: Apply anti-graffiti coatings according to manufacturer's written instructions.
1. Use applicators and techniques best suited for the material being applied.
 2. Do not apply anti-graffiti coatings over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to forming a durable coating film.
 3. Coating surface treatments and finishes are indicated in the coating system descriptions.
 4. Provide finish coats compatible with primers used.
 5. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, drinking fountains, grilles, covers for electrical equipment, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
- B. Coat surfaces behind movable equipment and furniture the same as similar exposed surfaces.
1. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
- C. Scheduling Coating: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for coating as soon as practicable after preparation and before subsequent surface deterioration.
- D. The number of coats and film thickness required is the same regardless of application method.
1. Micro-Seal- one (1) coat
 2. VandIGuard TEN- two (2) coats
 3. VandIGuard Finish Coat- one (1) coat
- E. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. Allow sufficient time between successive coats to permit proper drying.

- F. Give special attention to edges, corners, crevices, and similar surfaces to ensure that they receive a dry film thickness equivalent to that of flat surfaces.
- G. Application Procedures: Apply coatings according to manufacturer's written instructions.
 - 1. Spray Equipment: Use spray equipment with pressure and orifice size recommended by manufacturer for material and texture required.
- H. Minimum Coating Thickness: Apply each material no thinner than manufacturers recommended spreading rate.
 - 1. Provide total dry film thickness of the entire system as recommended by manufacturer.
- I. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by manufacturer, to material required to be coated or finished that has not been prime coated by others.
- J. Recoat primed and sealed substrates immediately if there is evidence of suction spots or unsealed areas in first coat, to ensure a finish coat with no burn-through or other defects caused by insufficient sealing.
- K. Completed Work: Match accepted mockups for shade and coverage. Remove, refinish, or recoat work that does not comply with specified requirements.

3.4 FIELD QUALITY CONTROL

- A. Provide the services of the manufacturer's authorized field representative to verify that installed products comply with manufacturer's requirements and with the standard established by the Architect approved mockup/test panels.
- B. Remove and replace work where test results indicate that it does not comply with specified requirements.

3.5 CLEANING

- A. Immediately clean anti-graffiti coatings from adjoining surfaces and surfaces soiled or damaged by application as work progresses. Repair damage caused by application. Comply with manufacturer's written cleaning instructions.
- B. Clean up debris and unused material and remove from site.

3.6 PROTECTION

- A. Protect work of other trades, whether being coated or not, against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.
- B. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

END OF SECTION 09 68 13

**SECTION 10 11 00
VISUAL DISPLAY UNITS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Porcelain enamel steel markerboards.
- B. Tackboards.

1.2 REFERENCE STANDARDS

- A. ANSI A208.1 - American National Standard for Particleboard 2016.
- B. ASTM A424/A424M - Standard Specification for Steel, Sheet, for Porcelain Enameling 2018.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's data on porcelain enamel steel markerboard, tackboard, tackboard surface covering, trim, and accessories.
- C. Shop Drawings: Indicate wall elevations, dimensions, joint locations , special anchor details.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.5 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year warranty for chalkboard and markerboard to include warranty against discoloration due to cleaning, crazing or cracking, and staining.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. ADP Lemco, Inc: www.adplemco.com.
- B. Claridge Products and Equipment, Inc; [____]: www.claridgeproducts.com.
- C. Nelson Adams NACO: www.nelsonadamsnaco.com.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 VISUAL DISPLAY UNITS

- A. Porcelain Enamel Steel Markerboards:
 - 1. Color: As selected from manufacturer's full range.
 - 2. Steel Face Sheet Thickness: 24 gauge, 0.0239 inch (0.61 mm).
 - 3. Core: Particleboard, manufacturer's standard thickness, laminated to face sheet.
 - 4. Backing: Aluminum foil, laminated to core.
 - 5. Size: As indicated on drawings.
 - 6. Frame: Extruded aluminum , with concealed fasteners.
 - 7. Frame Finish: Anodized, natural.
 - 8. Accessories: Provide marker tray and map rail.
- B. Tackboards: Fine-grained, homogeneous natural cork.
 - 1. Cork Thickness: 1/4 inch (6 mm).
 - 2. Backing: Hardboard, 1/4 inch (6 mm) thick, laminated to tack surface.
 - 3. Surface Burning Characteristics: Flame spread index of 25, maximum, and smoke developed index of 450, maximum, when tested in accordance with ASTM E84.
 - 4. Size: As indicated on drawings.

5. Frame: Extruded aluminum , with concealed fasteners.
6. Frame Profile: As indicated on drawings.
7. Frame Finish: Anodized, natural.

2.3 MATERIALS

- A. Porcelain Enameled Steel Sheet: ASTM A424/A424M, Type I, Commercial Steel, with fired-on vitreous finish.
- B. Particleboard: ANSI A208.1; wood chips, set with waterproof resin binder, sanded faces.
- C. Foil Backing: Aluminum foil sheet, 0.005 inch thick (0.13 mm thick).
- D. Adhesives: Type used by manufacturer.

2.4 ACCESSORIES

- A. Map Rail: Extruded aluminum, manufacturer's standard profile, with cork insert and runners for accessories; 1 inch wide overall (; 25 mm wide overall) , full width of frame.
- B. Map Supports: Formed aluminum sliding hooks and roller brackets to fit map rail.
- C. Marker Tray: Aluminum, manufacturer's standard profile, one piece full length of markerboard, molded ends, concealed fasteners, same finish as frame.
- D. Mounting Brackets: Concealed.



PART 3 - PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that internal wall blocking is ready to receive work and positioning dimensions are as indicated on shop drawings.

3.2 PREPARATION

- A. Acclimatize tackable wall panels by removing from packaging in installation area not less than 24 hours before application.

3.3 INSTALLATION

- A. Install boards in accordance with manufacturer's instructions.
- B. Install with top of marker tray at 34 inches (863 mm) above finished floor.
- C. Secure units level and plumb.

3.4 CLEANING

- A. Clean board surfaces in accordance with manufacturer's instructions.
- B. Remove temporary protective cover at Date of Substantial Completion.

END OF SECTION 10 11 00



**SECTION 10 14 00
SIGNAGE**



PART 1 - GENERAL

1.1 REFER TO APPENDIX 10 – DIVISION 10

END OF SECTION 10 14 00

**SECTION 10 21 13.19
PLASTIC TOILET COMPARTMENTS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Solid plastic toilet compartments.
- B. Urinal and vestibule screens.

1.2 REFERENCE STANDARDS

- A. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth 2019.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Not Applicable

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on panel construction, hardware, and accessories.
- C. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall supports, door swings.
- D. Manufacturer's Installation Instructions: Indicate special procedures.

1.5 CODE REQUIREMENTS

- A. Accessible Toilet Compartments:
 - 1. Wheelchair accessible compartment shall comply with CBC Section 11B-604.8.1.
 - 2. Toe clearance for at least one side partition of a wheelchair accessible compartment shall comply with CBC Section and Figure 11B-604.8.1.4. It shall be 9" high minimum above the finish floor and 6" deep minimum beyond the compartment side face of the partition, exclusive of partition support members. It shall be 12" high minimum above the finish floor for children's use. Partition components at toe clearances shall be smooth without sharp edges or abrasive surfaces. Toe clearance at the side partition is not required in a compartment greater than 66" wide.
 - 3. An ambulatory accessible compartment shall be provided where there are six or more toilet compartments, or where the combination of urinals and water closets totals six or more per CBC Section 11B-213.3.1. Such compartment shall comply with CBC Section 11B-604.8.2.
 - 4. Door and door hardware for accessible compartments shall be self-closing and shall comply with CBC Section 11B-404 except that pull-side clearance for ambulatory accessible compartments shall be minimum 44" clear, rather than 60". CBC Figure 11B-604.8.2.
 - 5. A door pull complying with CBC Section 11B-404.2.7 shall be placed on both sides of the door near the latch.
 - 6. Doors shall not swing into clear floor space or clearance required for any fixtures.

PART 2 - PRODUCTS

2.1 PLASTIC TOILET COMPARTMENTS

- A. Solid Plastic Toilet Compartments: Factory fabricated doors, pilasters, and divider panels made of solid molded high density polyethylene (HDPE), tested in accordance with NFPA 286; floor and ceiling anchored.
 - 1. Doors:
 - a. Thickness: 1 inch (25 mm).
 - b. Width: 24 inch (610 mm).
 - c. Width for Handicapped Use: 36 inch (915 mm), out-swinging.
 - d. Height: 55 inch (1397 mm).
 - 2. Panels:
 - a. Thickness: 1 inch (25 mm).

- b. Height: 55 inch (1397 mm).
- 3. Pilasters:
 - a. Thickness: 1 inch (25 mm).
 - b. Width: As required to fit space; minimum 3 inch (76 mm).
- 4. Screens: Without doors; to match compartments; mounted to wall with two panel brackets.

2.2 ACCESSORIES

- A. Pilaster Shoes: Stainless steel, satin finish, 3 inches (76 mm) high; concealing floor fastenings.
 - 1. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster.
 - 2. Provide ceiling attachment using two adjustable hanging studs, attached to above-ceiling framing.
- B. Wall and Pilaster Brackets: Stainless steel; manufacturer's standard type for conditions indicated on drawings.
- C. Attachments, Screws, and Bolts: Stainless steel, tamper proof type.
- D. Hinges: Stainless steel, manufacturer's standard finish.
 - 1. Continuous-type hinge, self closing.
- E. Door Hardware: Stainless steel, manufacturer's standard finish.
 - 1. Door Latch: Slide type with exterior emergency access feature.
 - 2. Door Strike and Keeper with Rubber Bumper: Mount on pilaster in alignment with door latch.
 - 3. Provide door pull for outswinging doors.
- F. Coat Hook: One per compartment, mounted on door.

PART 3 - PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify correct spacing of and between plumbing fixtures.
- C. Verify correct location of built-in framing, anchorage, and bracing.

3.2 INSTALLATION

- A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
- B. Maintain 3/8 inch to 1/2 inch (9 mm to 13 mm) space between wall and panels and between wall and end pilasters.
- C. Attach panel brackets securely to walls using anchor devices.
- D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.
- E. Field touch-up of scratches or damaged finish will not be permitted. Replace damaged or scratched materials with new materials.

3.3 TOLERANCES

- A. Maximum Variation From True Position: 1/4 inch (6 mm).
- B. Maximum Variation From Plumb: 1/8 inch (3 mm).

3.4 ADJUSTING

- A. Adjust hinges to position doors in partial opening position when unlatched. Return out-swinging doors to closed position.

END OF SECTION 10 21 13.19

**SECTION 10 26 00
WALL AND DOOR PROTECTION**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Bumper rails.
- B. Corner guards.

1.2 REFERENCE STANDARDS

- A. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics 2010 (Reapproved 2018).
- B. ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents 2020.
- C. ASTM F476 - Standard Test Methods for Security of Swinging Door Assemblies 2014.
- D. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015 (Reapproved 2021)e1.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate physical dimensions, features, wall mounting brackets with mounted measurements, anchorage details, and rough-in measurements.
- C. Samples: Submit samples illustrating component design, configurations, joinery, color and finish.
 - 1. Submit two sections of corner guards and bumper rails, 24 inches (610 mm) long.
- D. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wall and door protection items in original, undamaged protective packaging. Label items to designate installation locations.
- B. Protect work from moisture damage.
- C. Do not deliver products to project site until areas for storage and installation are fully enclosed, and interior temperature and humidity are in compliance with manufacturer's recommendations for each type of item.
- D. Store products in either horizontal or vertical position, in compliance with manufacturer's instructions.

1.5 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a one year period after Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Wall Guards:
 - 1. Basis of Design: [Acrovyn SCR-40N](#) or equal.
 - 2. Basis of Design: [Acrovyn Rubstrip](#) in stainless steel or equal; adhesively attached (at all walls of "Storage" space).
- B. Corner Guards:
 - 1. Basis of Design: Acrovyn [CO-8](#) or equal; mechanically fastened.

2.2 PERFORMANCE CRITERIA

- A. Impact Strength: Unless otherwise noted, provide protection products and assemblies that have been successfully tested for compliance with applicable provisions of ASTM D256 and/or ASTM F476.

- B. Chemical and Stain Resistance: Unless otherwise noted, provide protection products and assemblies with chemical and stain resistance complying with applicable provisions of ASTM D543.
- C. Fungal Resistance: Unless otherwise noted, provide protection products and assemblies which pass ASTM G21 testing.

2.3 PRODUCT TYPES

- A. Bumper Rails: Factory- or shop-fabricated, with preformed end caps and internal and external corners:
 - 1. Material: High impact vinyl, color as selected from manufacturer's standard colors.
 - 2. Mounting: Surface.
 - 3. Return rail to wall.
- B. Corner Guards - Flush Mounted:
 - 1. Material: Type 304 stainless steel, No. 4 finish, 16 gauge.
 - 2. Performance: Resist lateral impact force of 100 lbs (445 N) at any point without damage or permanent set.
 - 3. Width of Wings: 2 inches (51 mm).
 - 4. Corner: Square.
 - 5. Color: As selected from manufacturer's standard colors.
 - 6. Length: One piece.

2.4 FABRICATION

- A. Fabricate components with tight joints, corners and seams.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.
- B. Verify that field measurements are as indicated on drawings.
- C. Verify that substrate surfaces for adhered items are clean and smooth.
 - 1. Test painted or wall covering surfaces for adhesion in inconspicuous area, as recommended by manufacturer. Follow adhesive manufacturer's recommendations for remedial measures at locations and/or application conditions where adhesion test's results are unsatisfactory.

3.2 INSTALLATION

- A. Position top of bumper rail 36 inches (914 mm) from finished floor.
- B. Position corner guard 4 inches (102 mm) above finished floor to [] inches high ([] mm high).
- C. Terminate rails 1 inch (25.4 mm) short of door openings and intersecting walls.

3.3 TOLERANCES

- A. Maximum Variation From Required Height: 1/4 inch (6 mm).
- B. Maximum Variation From Level or Plane For Visible Length: 1/4 inch (6 mm).

3.4 CLEANING

- A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.
- B. Clean wall and door protection items of excess adhesive, dust, dirt, and other contaminants.

END OF SECTION 10 26 00

**SECTION 10 28 00
TOILET, BATH, AND LAUNDRY ACCESSORIES**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Commercial toilet accessories.
- B. Under-lavatory pipe supply covers.
- C. Utility room accessories.

1.2 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.
- B. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service 2015a (Reapproved 2019).
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- E. ASTM C1036 - Standard Specification for Flat Glass 2021.
- F. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror 2018.
- G. ASTM C1822 - Standard Specification for Insulating Covers on Accessible Lavatory Piping 2021.
- H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- I. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015 (Reapproved 2021)e1.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: [Bobrick Washroom Equipment, Inc.](#); All items are to be contractor supplied and installed, unless noted otherwise..
- B. Commercial Toilet, Shower, and Bath Accessories:
 - 1. Bradley Corporation: www.bradleycorp.com.
 - 2. Substitutions: Section 01 60 00 - Product Requirements.

2.2 ACCESSIBILITY COMPLIANCE

- A. Elements of Sanitary facilities shall be mounted at locations in compliance with CBC requirements.
- B. Grab bars in toilet facilities and bathing facilities shall comply with CBC requirements. Grab bars and any wall or other surfaces adjacent to grab bars shall be free of sharp or abrasive elements and shall have rounded edges.

2.3 MATERIALS

- A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.

1. Grind welded joints smooth.
- B. Keys: Provide two keys for each accessory to Owner; master key lockable accessories.
- C. Stainless Steel Sheet: ASTM A666, Type 304.
- D. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.
- E. Galvanized Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.
- F. Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.
- G. Adhesive: Two component epoxy type, waterproof.
- H. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

2.4 FINISHES

- A. Stainless Steel: Satin finish, unless otherwise noted.

2.5 COMMERCIAL TOILET ACCESSORIES

- A. Toilet Paper Dispenser:
 1. Double roll, semi-recessed, stainless steel unit with pivot hinge, tumbler lock.
 - a. Bobrick B-6997 Recessed Dual Roll Toilet Tissue Dispenser w/ Hood – Satin Finish.
 2. Single roll, surface mounted large capacity.
 - a. Tork 554028A with Reserve
- B. Combination Toilet Paper/Seat Cover Dispenser with Napkin Disposal: Double roll; Recessed flush with wall, stainless steel; seamless wall flanges, continuous piano hinges.
 1. Minimum capacity: 500 seat covers.
 2. Waste receptacle capacity: 0.4 gallons (1.5 liters).
 3. Products:
 - a. Bobrick B-3091/3092 ClassicSeries® Recessed Sanitary Napkin Disposal, Seat Cover and Toilet Tissue Dispenser.
- C. Combination Toilet Paper/Seat Cover Dispenser with Napkin Disposal; Double roll; Surface mount to wall/partition, stainless steel, continuous piano hinges.
 1. Minimum Capacity: 500 seat covers
 2. Waste receptacle capacity: 0.4 gallons (1.5 liters).
 3. Products:
 - a. Bobrick B-30919/30929 ClassicSeries Surface-Mounted Toilet Seat-Cover Dispenser, Waste Disposal, and Toilet Tissue Dispenser
- D. Seat Cover Dispenser: Stainless steel, surface mount, reloading by concealed opening at base.
 1. Minimum capacity: 250 seat covers.
 2. Products:
 - a. Bobrick B-221 ClassicSeries Surface-Mounted Seat-Cover Dispenser
- E. Seat Cover Dispenser: Stainless steel, recessed, reloading by concealed opening at base, tumbler lock.
 1. Minimum capacity: 500 seat covers.
 2. Products:
 - a. Bobrick B-301 ClassicSeries Recessed Seat Cover Dispenser.
- F. Combination Towel Dispenser/Waste Receptacle: Recessed flush with wall, stainless steel; seamless wall flanges, continuous piano hinges, [____].
 1. Waste receptacle liner: Reusable, heavy-duty vinyl.
 2. Towel dispenser capacity: 400 C-fold.
 3. Waste receptacle capacity: 12 gallons (45 liters).
 4. Products:
 - a. Bobrick B-3944 Recessed Paper Towel Dispenser and Waste Receptacle.

- G. Waste Receptacle:
 - 1. Waste receptacle liner: Reusable, heavy-duty vinyl.
 - 2. Waste receptacle capacity: 12.8 gal (48.3 L).
 - 3. Products:
 - a. Bobrick B-43644 Contura Series Recessed Waste Receptacle with LinerMate
- H. Surface Mounted Towel Dispenser:
 - 1. Towel dispenser capacity: 400 C-fold
 - 2. Products:
 - a. Bobrick B-262 ClassicSeries Surface-Mounted Paper Towel Dispenser
- I. Menstrual Waste Disposal
 - 1. Dispenser: Wall Mounted
 - 2. Capacity: 50 Disposal Bags
 - 3. Products:
 - a. MaskIt Single Stall Kit
- J. Automated Soap Dispenser: Foam soap dispenser, deck-mounted on vanity, with container concealed below deck; chrome-plated brass with bright polished finish; chrome-plated deck escutcheon.
 - 1. Minimum Capacity: 50 ounces (1.50 liters).
 - 2. Power: Hardwired.
 - 3. Products:
 - a. Sloan ESD-2000 CP, hardwired, include Sloan ESD-324 6 volt AC adapter.
- K. Mirrors: Stainless steel framed, 1/4 inch (6 mm) thick annealed float glass; ASTM C1036.
 - 1. Size: As indicated on drawings.
 - 2. Frame: 0.05 inch (1.3 mm) channel shapes, with mitered and welded and ground corners, and tamperproof hanging system; satin finish.
 - 3. Backing: Full-mirror sized, minimum 0.03 inch (0.8 mm) galvanized steel sheet and nonabsorptive filler material.
 - 4. Shelf: Stainless steel; gauge and finish to match mirror frame, turned down edges, welded to frame; 5 inches (125 mm) deep, full width of mirror.
 - 5. Products:
 - a. Bobrick B-166 1836 Mirror with Stainless Steel Channel Frame and Shelf.
- L. Grab Bars: Stainless steel, peened surface.
 - 1. Standard Duty Grab Bars:
 - a. Push/Pull Point Load: 250 pound-force (1112 N), minimum.
 - b. Dimensions: 1-1/2 inch (38 mm) outside diameter, minimum 0.05 inch (1.3 mm) wall thickness, exposed flange mounting, 1-1/2 inch (38 mm) clearance between wall and inside of grab bar.
 - c. Finish: Satin.
 - d. Length and Configuration: As indicated on drawings.
 - e. Finishing: Grab bars and any wall or other surfaces adjacent to grab bars shall be free of sharp or abrasive elements and shall have rounded edges.
 - f. Products:
 - 1) Bobrick B-6806.99 Series Straight Grab Bar 1-1/2" DIA x 36" Peened Grip.
- M. Shelf: Stainless steel with satin finish.
 - 1. Size: 18" in length x 6" in depth
 - 2. Products:
 - a. Bobrick B-296x18 Stainless Steel Shelf
- N. Baby Changing Station
 - 1. Products:
 - a. Koala Kare KB310-SSRE

2.6 UNDER-LAVATORY PIPE AND SUPPLY COVERS

A. Under-Lavatory Pipe and Supply Covers:

1. Insulate exposed drainage piping, including hot, cold, and tempered water supplies under lavatories or sinks to comply with ADA Standards.
2. Exterior Surfaces: Smooth non-absorbent, non-abrasive surfaces.
3. Construction: 1/8 inch (3.2 mm) flexible PVC.
 - a. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - b. Comply with ASTM C1822, type indicated.
 - c. Microbial and Fungal Resistance: Comply with ASTM G21.
4. Color: White.
5. Fasteners: Reusable, snap-locking fasteners with no sharp or abrasive external surfaces.
6. Products:
 - a. Plumberex Specialty Products, Inc; Plumberex Handy-Shield Maxx: www.plumberex.com.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.7 UTILITY ROOM ACCESSORIES

- A. Combination Utility Shelf/Mop and Broom Holder: 0.05 inch (1.3 mm) thick stainless steel, Type 304, with 1/2 inch (12 mm) returned edges, 0.06 inch (1.6 mm) steel wall brackets.
1. Drying rod: Stainless steel, 1/4 inch (6 mm) diameter.
 2. Hooks: Two, 0.06 inch (1.6 mm) stainless steel rag hooks at shelf front.
 3. Mop/broom holders: Three spring-loaded rubber cam holders at shelf front.
 4. Length: Manufacturer's standard length for number of holders/hooks.
 5. Products:
 - a. Bobrick B-239×34 Classic Series Shelf with Mop and Broom Holders and Hooks.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.
- C. For electrically-operated accessories, verify that electrical power connections are ready and in the correct locations.
- D. Verify that field measurements are as indicated on drawings.

3.2 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.3 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.
- D. Shelving to occur above all Urinals and Water Closets.

3.4 PROTECTION

- A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION 10 28 00

**SECTION 10 44 00
FIRE PROTECTION SPECIALTIES**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.
- C. Accessories.

1.2 REFERENCE STANDARDS

- A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).
- B. FM (AG) - FM Approval Guide current edition.
- C. NFPA 10 - Standard for Portable Fire Extinguishers 2022.
- D. UL (DIR) - Online Certifications Directory Current Edition.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide extinguisher operational features.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.4 CODE REQUIREMENTS

- A. Fire Extinguisher Cabinets
 - 1. Fire Extinguisher Cabinets must comply with CBC Sections 11B-307, 11B-308, 11B-309 and 11B-403.

1.5 FIELD CONDITIONS

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Fire Extinguishers:
 - 1. Activar Construction Products Group, Inc. - JL Industries: www.activarcpg.com.
 - 2. Nystrom, Inc: www.nystrom.com.
 - 3. Potter-Roemer: www.potterroemer.com.

2.2 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
 - 1. Provide extinguishers labeled by UL (DIR) or FM (AG) for purpose specified and as indicated.
- B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
 - 1. Class: A:B:C type.
 - 2. Finish: Baked polyester powder coat, red color.

2.3 FIRE EXTINGUISHER CABINETS

- A. Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.
- B. Fire Rated Cabinet Construction: One-hour fire rated.
- C. Cabinet Configuration: Recessed type.
 - 1. Size to accommodate accessories.



2. Trim: Flat square edge.
 3. Provide cabinet enclosure with right angle inside corners and seams, and with formed perimeter trim and door stiles.
- D. Door: 0.036 inch (0.9 mm) metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinges.
 - E. Door Glazing: Float glass, clear, 1/8 inch (3 mm) thick, and set in resilient channel glazing gasket.
 - F. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
 - G. Fabrication: Weld, fill, and grind components smooth.
 - H. Finish of Cabinet Exterior Trim and Door: No.4 - Brushed stainless steel.

2.4 ACCESSORIES

- A. Lettering: FIRE EXTINGUISHER decal, or vinyl self-adhering, pre-spaced black lettering in accordance with authorities having jurisdiction (AHJ).



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify rough openings for cabinet are correctly sized and located.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure rigidly in place.

END OF SECTION 10 44 00

**SECTION 10 71 13.43
FIXED SUN SCREENS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Modular, shop fabricated, extruded aluminum sun screens to be mounted on structure provided by others.

1.2 REFERENCE STANDARDS

- A. AAMA 612 - Voluntary Specification, Performance Requirements, and Test Procedures for Combined Coatings of Anodic Oxide and Transparent Organic Coatings on Architectural Aluminum; current edition.
- B. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; current edition.
- C. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; current edition.
- D. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; current edition.
- E. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; current edition.
- F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; current edition.
- G. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; current edition.
- H. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs; current edition.

1.3 SUBMITTALS

- A. Shop Drawings: Prior to commencement of fabrication, submit detailed shop drawings, showing all profiles, sections of all components, finishes, fastening details, and manufacturer's technical and descriptive data. Include field dimensions of openings and elevations on shop drawings.
- B. Design Data: Submit comprehensive structural analysis of design for the specified loads. Stamp and sign calculations by professional engineer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section.
 - 1. With minimum five years of documented experience.
 - 2. Approved by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to project site ready for erection.
- B. Package using methods that prevent damage during shipping and storage on site.
- C. Store materials under cover and elevated above grade.

1.6 WARRANTY

- A. Sun Screens: Correct defective work within a one year period after Date of Substantial Completion.
- B. Finish Warranty: Provide manufacturer's one year warranty on factory finish against cracking, peeling, and blistering.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Fixed Sun Screens:
 - 1. Basis of Design: CS Specialties.



2.2 SUN SCREENS

- A. Sun Screens: Shop fabricated, shop finished, extruded aluminum outriggers, louvers, and fascia, free of defects impairing strength, durability or appearance.
 - 1. Configuration: As indicated on drawings.
 - 2. Louver Type: Airfoil.
 - 3. Sun Screen Angle: 40 degrees from horizontal.
 - 4. Outrigger Shape: Wedge.
 - 5. Design Criteria: Design and fabricate to resist the following loads without failure, damage, or permanent deflection:
 - a. As indicated on structural drawings
 - b. Thermal Movement: Plus/minus 1/8 inch, maximum.
 - 6. Sizes: As indicated on drawings.
 - 7. Exposed Aluminum Finish: Match Aluminum-Framed Storefront framing, refer to section for finish information.
 - 8. Provide a complete system ready for erection at project site.
 - 9. Shop fabricate to the greatest extent possible; disassemble if necessary for shipping.

2.3 MATERIALS

- A. Aluminum Extrusions: ASTM B209 (ASTM B209M) or ASTM B221 (ASTM B221M).
- B. Aluminum Coated Steel Sheet: ASTM A792/A792M.
- C. Concealed Structural Supports: Aluminum, or steel coated for corrosion resistance and dissimilar metal isolation.
- D. Fasteners: ASTM F593 stainless steel.

PART 3 - EXECUTION

3.1 NOT APPLICABLE

END OF SECTION 10 71 13.43



**SECTION 12 22 16
DRAPERY TRACK AND ACCESSORIES**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Formed steel track.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate location and installation of concealed blocking for support of tracks.

1.3 SUBMITTALS

- A. See Administrative Requirements, for submittal procedures.
- B. Product Data: Provide track profiles, acceptable load data, and finishes available.
- C. Shop Drawings: Indicate end track location, width of window opening, location of blocking for anchors, appurtenances and interferences, adjacent construction, operating hardware, and support bracket details.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Drapery Track:
 - 1. SWFcontract, a division of Springs Window Fashions, LLC: www.swfcontract.com.
 - 2. Or Equal.

2.2 COMPONENTS

- A. Tracks: Formed steel, side stacking operating traverse rods, heavy duty channel track.
- B. Track Brackets: Formed steel wall type, for recessed installation, with screws and inserts for attachment.
- C. Control Wand: Extruded aluminum; round shape; non-removable type; length of window opening height less 3 inches.

2.3 FINISHES

- A. Exposed Surfaces: Baked enamel, white.

END OF SECTION 12 22 16



**SECTION 12 24 00
WINDOW SHADES**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Interior manual roller shades.
- B. Interior motorized roller shades.
- C. Motor controls.

1.2 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems Current Edition, Including All Revisions.
- C. WCMA A100.1 - Safety of Window Covering Products 2018.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Where motorized shades are to be controlled by control systems provided under other sections, coordinate the work with other trades to provide compatible products.
 - 2. Coordinate the work with other trades to provide rough-in of electrical wiring as required for installation of hardwired motorized shades.
- B. Sequencing:
 - 1. Do not fabricate shades until field dimensions for each opening have been taken with field conditions in place.
 - 2. Do not install shades until final surface finishes and painting are complete.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data:
 - 1. Provide manufacturer's standard catalog pages and data sheets, including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.
 - 2. Motorized Shades: Include power requirements and standard wiring diagrams for specified products.
- C. Shop Drawings:
 - 1. Include shade schedule indicating size, location and keys to details, head, jamb and sill details, mounting dimension requirements for each product and condition, and operation direction.
 - 2. Motorized Shades: Provide schematic system riser diagram indicating component interconnections. Include requirements for interface with other systems.
- D. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of this type with minimum three years of documented experience with shading systems of similar size and type.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver shades in manufacturer's unopened packaging, labeled to identify each shade for each opening.
- B. Handle and store shades in accordance with manufacturer's recommendations.

1.7 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide manufacturer's warranty from Date of Substantial Completion, covering the following:
 - 1. Shade Hardware: One year.
 - 2. Electric Motors: One year.
 - 3. Electronic Control Equipment: One year.
 - 4. Fabric: One year.
 - 5. Aluminum and Steel Coatings: One year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Interior Manually Operated Roller Shades:
 - 1. MechoShade Systems LLC; Mecho/7 System: www.mechoshade.com/#sle.
- B. Interior Motorized Roller Shades, Motors and Motor Controls:
 - 1. MechoShade Systems LLC; UrbanShade Single Roller - Motorized: www.mechoshade.com/#sle.
- C. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
 - 1. "MechoShade is a Board of Trustees Approved Sole Source Item. No substitutions will be accepted."

2.2 ROLLER SHADES

- A. General:
 - 1. Provide shade system components that are easy to remove or adjust without removal of mounted shade brackets.
 - 2. Provide shade system that operates smoothly when shades are raised or lowered.
 - 3. Motorized Shades: Motor system housed inside roller tube, controlling shade movement via motor controls indicated; listed or recognized to UL 325.
 - a. Comply with NFPA 70.
 - b. Electrical Components: Listed, classified, and labeled as suitable for the purpose intended. Where applicable, system components to be FCC compliant.
 - c. Motors: Size and configuration as recommended by manufacturer for the type, size, and arrangement of shades to be operated; integrated into shade operating components and concealed from view; fully compatible with controls to be installed.
- B. Roller Shades - Basis of Design: MechoShade Systems LLC; Mecho/5 System; www.mechoshade.com
 - 1. Description: Single roller, manually operated fabric window shades.
 - a. Drop Position: Regular roll.
 - b. Size: As indicated on drawings.
 - 2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
 - 3. Roller Tubes:
 - a. Material: Extruded aluminum.

- b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
 - c. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge. Shade band to be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.
 - d. Roller tubes to be capable of being removed and reinstalled without affecting roller shade limit adjustments.
4. Hembars: Designed to maintain bottom of shade straight and flat.
 - a. Style: Full wrap fabric covered bottom bar, flat profile with heat sealed closed ends.
 - b. Room-Darkening Shades: Provide a slot in bottom bar with wool-pile light seal.
 5. Clutch Operator: Manufacturer's standard material and design integrated with bracket/brake assembly.
 - a. Provide a permanently lubricated brake assembly mounted on an oil-impregnated hub with wrapped spring clutch.
 - b. Brake must withstand minimum pull force of 50 pounds (22.7 kg) in the stopped position.
 - c. Mount clutch/brake assembly on the support brackets, fully independent of the roller tube components.
 6. Drive Chain: Continuous loop stainless steel beaded ball chain, 95 pound (43 kg) minimum breaking strength. Provide upper and lower limit stops.
 - a. Chain Retainer: Chain tensioning device complying with WCMA A100.1.
- C. Roller Shades - Basis of Design: MechoShade Systems LLC; UrbanShade Single Roller - Motorized, with wired control ; www.mechoshade.com
1. Description: Single roller, manually operated fabric window shade system complete with mounting brackets, roller tubes, hembars, hardware, and accessories.
 - a. Drop Position: Regular roll.
 2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
 3. Roller Tubes:
 - a. Material: Extruded aluminum.
 - b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
 - c. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge. Shade band to be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.
 4. Hembars: Designed to maintain bottom of shade straight and flat.
 - a. Style: Full wrap fabric covered bottom bar, flat profile with heat sealed closed ends.
 - b. Room-Darkening Shades: Provide a slot in bottom bar with wool-pile light seal.
 5. Manual Operation:
 - a. Clutch Operator: Manufacturer's standard material and design integrated with bracket/brake assembly.
 - 1) Provide brake assembly mounted on a low-friction plastic hub with wrapped spring clutch.
 - 2) Brake must withstand minimum pull force of 25 pounds (12 kg) in the stopped position.
 - 3) Mount clutch/brake assembly on the support brackets, fully independent of the roller tube components.

- b. Drive Chain: Continuous loop beaded ball chain. Provide upper and lower limit stops.
 - 1) Chain must withstand a breaking force of no less than 45 pound-force (200 N).
 - 2) Chain Retainer: Chain tensioning device complying with WCMA A100.1.
- 6. Accessories:
 - a. Fascia: Extruded aluminum, size as required to conceal shade mounting, attachable to brackets without exposed fasteners; clear anodized finish.
 - 1) Color: Black.
 - 2) Profile: Square.
 - b. Ceiling Pockets: Premanufactured metal shade pocket with removable closure panel, for recess mounting in acoustical tile or drywall ceilings; size and configuration as indicated on drawings.
 - c. Room-Darkening Channels: Extruded aluminum side and center channels with brush pile edge seals, SnapLoc mounting base, and concealed fasteners. Channels to accept one-piece exposed blackout hembar to assure side light control and sill light control. Locations as required and shall be coordinated with emergency egress lighting.
 - d. Fasteners: Noncorrosive, and as recommended by shade manufacturer.

2.3 SHADE FABRIC

- A. Fabric: Nonflammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.
 - 1. Manufacturers:
 - a. MechoShade Systems LLC; Soho - 1100 Series (1% open)
 - b. MechoShade Systems LLC; Soho – 0700 Series (Blackout)

2.4 MOTOR CONTROLS

- A. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the control intent indicated.
- B. Provide all components and connections necessary to interface with other systems as indicated.
- C. Digital Network Controls:
 - 1. Intelligent Motors and Devices: Identifiable over network without separate interface.
 - 2. Provide suitable interface modules as indicated or as required for connection to standard (nonintelligent) motors and devices.
 - 3. Capable of reprogrammed control without requiring wiring modifications.
 - 4. Capable of assigning shade motors to shade groups/sub-groups.
 - 5. Capable of storing programmable open and close limits and minimum of three intermediate preset stop positions for each shade.
 - 6. Capable of aligning adjacent shades within accuracy of plus/minus 0.25 inch (6.4 mm).
 - 7. Provide 10 year nonvolatile power failure memory for system configuration settings.
 - 8. Basis of Design: MechoShade Systems LLC; MechoNet: www.mechoshade.com.
 - a. Low-voltage network utilizes standard Category 5/6 UTP cable; maximum of 4,000 feet (1,219 m), 250 nodes.
 - b. Network Interface Components:
 - 1) MechoNet Network Interface; MNI Series: Four configurable motor/EDU ports (models available for RJ45 or terminal block wiring); four configurable switch ports; one infrared (IR) remote control port; one configurable serial port for RS232/RS485 communication.

- 2) IQ2 Dual Splitter: Two motor/EDU ports; two switch ports.
- D. Manual Controls:
 1. Control Functions:
 - a. Open: Automatically open controlled shade(s) to fully open position when button is pressed.
 - b. Close: Automatically close controlled shade(s) to fully closed position when button is pressed.
 2. Handheld Remote Controls: Battery-powered; wireless (radio frequency) or infrared; provided by shade manufacturer.
 - a. Wireless (Radio Frequency) Range: 30 feet (9 m).
 - b. Finish: Manufacturer's standard finish, unless otherwise indicated.

2.5 ROLLER SHADE FABRICATION

- A. Field measure finished openings prior to ordering or fabrication.
- B. Dimensional Tolerances: Fabricate shades to fit openings within specified tolerances.
- C. Vertical Dimensions: Fill openings from head to sill with 1/2 inch (13 mm) space between bottom bar and window stool.
 1. Horizontal Dimensions - Inside Mounting: Fill openings from jamb to jamb.
 2. Dimensional Tolerances: As recommended in writing by manufacturer.
- D. At openings requiring continuous multiple shade units with separate rollers, locate roller joints at window mullion centers; butt rollers end-to-end.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine finished openings for deficiencies that may preclude satisfactory installation.
- B. Start of installation shall be considered acceptance of substrates.

3.2 PREPARATION

- A. Prepare surfaces using methods recommended by manufacturer for achieving best result for substrate under the project conditions.
- B. Coordinate with window installation and placement of concealed blocking to support shades.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved shop drawings, using mounting devices as indicated.
- B. Replace shades that exceed specified dimensional tolerances at no extra cost to Owner.
- C. Adjust level, projection, and shade centering from mounting bracket. Verify there is no telescoping of shade fabric. Ensure smooth shade operation.
- D. Schedule
 1. Interior Windows: All windows to receive 1% Fabric
 2. Exterior Windows: All windows to receive 1% and Blackout Fabric

3.4 CLEANING

- A. Clean soiled shades and exposed components as recommended by manufacturer.
- B. Replace shades that cannot be cleaned to "like new" condition.
- C. See Section 01 74 19 - Construction Waste Management and Disposal for additional requirements.

3.5 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.



3.6 PROTECTION

- A. Protect installed products from subsequent construction operations.
- B. Touch-up, repair, or replace damaged products before Substantial Completion.
- C. med steel track.

END OF SECTION 12 40 00

**SECTION 12 36 00
COUNTERTOPS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Countertops for architectural cabinet work.
- B. Wall-hung counters and vanity tops.

1.2 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; current edition.
- B. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; current edition.
- C. ISFA 2-01 - Classification and Standards for Solid Surfacing Material; current edition.
- D. NEMA LD 3 - High-Pressure Decorative Laminates; current edition.
- E. PS 1 - Structural Plywood; current edition.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Specimen warranty.
- B. Shop Drawings: Complete details of materials and installation; combine with shop drawings of cabinets and casework specified in other sections.
- C. Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and patterns.
- D. Test Reports: Chemical resistance testing, showing compliance with specified requirements.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Same fabricator as for cabinets on which tops are to be installed.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COUNTERTOPS

- A. Plastic Laminate Countertops (Typical): High-pressure decorative laminate (HPDL) sheet bonded to substrate.
 - 1. Laminate Sheet: NEMA LD 3, Grade HGS, 0.048 inch nominal thickness.
 - a. Manufacturers:
 - 1) Formica Corporation: www.formica.com.
 - 2) Lamin-Art, Inc.: www.laminart.com.
 - 3) Panolam Industries International, Inc.\Nevamar: www.nevamar.com.
 - 4) Panolam Industries International, Inc.\Pionite: www.pionitelaminates.com.
 - 5) Wilsonart, LLC: www.wilsonart.com.
 - 6) Or Equal.
 - b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - c. Laminate Core Color: Same as decorative surface.



- d. Finish: Matte or suede, gloss rating of 5 to 20.
- e. Surface Color and Pattern: As selected by Architect from the manufacturer's full line.
- 2. Exposed Edge Treatment: Square, substrate built up to minimum 1-1/2 inch thick; covered with matching laminate.
- 3. Back and End Splashes: Same material, same construction.
- B. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
 - 1. Flat Sheet Thickness: 1/2 inch, minimum.
 - 2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Manufacturers:
 - 1) Avonite Surfaces: www.avonitesurfaces.com.
 - 2) Dupont: www.corian.com.
 - 3) Formica Corporation: www.formica.com.
 - 4) Wilsonart, LLC: www.wilsonart.com.
 - 5) Or Equal.
 - b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - c. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
 - d. Color and Pattern: As selected by Architect from manufacturer's full line.
 - 3. Other Components Thickness: 1/2 inch, minimum.
 - 4. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; square edge.
 - 5. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.
 - 6. Skirts: As indicated on drawings.
 - 7. Fabricate in accordance with AWI/AWMAC/WI (AWS), Section 11 - Countertops, Custom Grade.

2.2 MATERIALS

- A. Wood-Based Components:
 - 1. Wood fabricated from old growth timber is not permitted.
- B. Plywood for Supporting Substrate: PS 1 Exterior Grade, A-C veneer grade, minimum 5-ply; minimum 3/4 inch thick; join lengths using metal splines.
- C. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
- D. Joint Sealant: Mildew-resistant silicone sealant, white.

2.3 FABRICATION

- A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
 - 1. Join lengths of tops using best method recommended by manufacturer.
 - 2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
 - 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
 - 1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
 - 2. Height: 4 inches, unless otherwise indicated.
- C. Solid Surfacing: Fabricate tops up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.
- D. Wall-Mounted Counters: Provide skirts, aprons, brackets, and braces as indicated on drawings, finished to match.



END OF SECTION 12 36 00

**SECTION 12 93 00
SITE FURNISHINGS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Include all services, labor, materials, transportation, tools and equipment necessary to perform the work indicated on the Drawings and specified herein as required to properly complete the work in this contract.
- B. Related Documents: The Condition of the Contract and Division 1 apply to this section as fully as if repeated herein.
- C. Related Work Specified Elsewhere:
 - 1. 01 56 39 Tree and Plant Protection
 - 2. 03 33 10 Landscape Site Concrete Walls
 - 3. 31 10 00 Site Clearing
 - 4. 31 22 00 Grading
 - 5. 32 12 17 Decomposed Granite Paving
 - 6. 32 13 13 Concrete Paving
 - 7. 32 13 16 Decorative Concrete Paving
 - 8. 32 14 13 Unit Paving
 - 9. 32 84 00 Landscape Irrigation
 - 10. 32 93 13 Lawns and Grasses
 - 11. 32 93 16 Exterior Plants
 - 12. 33 41 11 Storm Utility Drainage Piping

1.2 SUBMITTALS

- A. All submittals to comply with Division 1 submittal procedures. Submit the following:
 - 1. Manufacturer's Data: Include manufacturer's data sheets, and shop drawings for all furnishing items
 - 2. Representative samples of colors and finish
 - 3. Manufacturer's instructions, maintenance recommendations, and warranty

1.3 SITE CONDITIONS

- A. Prior to commencing with work, review on site grading conditions, including sub grade conditions, verify the elevations, and dimensions, and notify the College's Representative of unsatisfactory conditions. Proceeding with the work constitutes acceptance of existing or corrected conditions.



PART 2 - PRODUCTS

2.1 FURNISHINGS

- A. Refer to most current version of the "Furniture Standards Program", not included within this document.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify exact locations for all furnishings coordinate installation and equipment with the College's Representative.
- B. All Products to be protected from damage during installation and from ongoing construction operations. Any site furnishings damaged prior to College's acceptance to be replaced at the Design-Builder's expense.
- C. Trash/Ash/Recycling Receptacles: Place furnishings as directed in the field. Install security cable and surface mount per manufacturer's recommendations.
- D. Bike Racks: Install per detail and Manufacturer's recommendations as directed in the field.



3.2 ACCEPTANCE

- A. Review and acceptance of the placement and installation to be performed by the College's Representative. Provide notification at least forty-eight (48) hours prior requested inspection time and date.

3.3 CLEAN-UP

- A. Perform cleaning during installation of the work and upon completion of the work. Remove from the site all excess materials, debris, and equipment.

END OF SECTION 12 93 00

**SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING**

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Sleeves.
 - 5. Escutcheons.
 - 6. Grout.
 - 7. Plumbing demolition.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Concrete bases.
 - 10. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 SUBMITTALS

- A. Welding certificates.
- B. Product Information for approval before purchase
- C. Operation and Maintenance Manuals

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.
- G. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.

2.3 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Carbon steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - a. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
 - 2. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 3. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 4. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.



3.2 PLUMBING RENOVATION

- A. For Renovation Projects that include plumbing:
 - 1. Replace water piping and fixtures and/or valves servicing the building 4'-0" prior to POC.
 - 2. Replace backflow make-up assembly and pressure regulator.

3. Install gages before and after regulator.

3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.4 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping



systems.

- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.5 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of

dissimilar metals.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.7 CONCRETE BASES

- E. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES.

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.9 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 22 05 00

**SECTION 22 05 13
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.



- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
 - 2. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 22 05 13

SECTION 22 05 16
EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 1. Rubber union connector packless expansion joints.
 2. Flexible-hose packless expansion joints.
 3. Metal-bellows packless expansion joints.
 4. Externally pressurized metal-bellows packless expansion joints.
 5. Rubber packless expansion joints.
 6. Grooved-joint expansion joints.
 7. Alignment guides and anchors.
 8. Pipe loops and swing connections.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Delegated-Design Submittal: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.2 PACKLESS EXPANSION JOINTS

- A. Rubber Union Connector Expansion Joints RUEJ-01:



1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Mason Industries, Inc.
 - d. Unisource Manufacturing, Inc.
 2. Material: Twin reinforced-rubber spheres with external restraining cables.
 3. Minimum Pressure Rating: 150 psig at 170 deg F, unless otherwise indicated.
 4. End Connections for NPS 2 and Smaller: Threaded.
- B. Flexible-Hose Packless Expansion Joints FHEJ-01:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Mason Industries, Inc.
 - d. Metraflex Company (The).
 2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
 3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
 4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
 - a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
 - b. Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
 5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg Fratings.
 6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.
 7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged or welded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
 8. Expansion Joints for Steel Piping NPS 8 to NPS 12: Carbon-steel fittings with flanged or welded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
 9. Expansion Joints for Steel Piping NPS 14 and Larger: Carbon-steel fittings with flanged or welded end connections.

- 1) Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
- C. Metal-Bellows Packless Expansion Joints MBEJ-01:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Expansion Joint Systems, Inc.
 - b. Flex-Hose Co., Inc.
 - c. Flexicraft Industries.
 - d. Mason Industries, Inc.
 - e. Metraflex Company (The).
 2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
 3. Type: Circular, corrugated bellows with external tie rods.
 4. Minimum Pressure Rating: 150 psig to 200 psig, unless otherwise indicated.
 5. Configuration: Single joint with base or double joint with base class(es), unless otherwise indicated.
 6. Expansion Joints for Copper Tubing: Single- or multi- ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
 - a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
 - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint or threaded.
 - c. End Connections for Copper Tubing NPS 5 and Larger: Flanged.
 7. Expansion Joints for Steel Piping: Single- or multi- ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.
 - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
 - b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Flanged or Welded.
- D. Externally Pressurized Metal-Bellows Packless Expansion Joints EPEJ-01:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flex-Hose Co., Inc.
 - b. Mason Industries, Inc.
 - c. Metraflex Company (The).
 - d. U.S. Bellows, Inc.
 2. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
 3. Description:
 - a. Totally enclosed, externally pressurized, multi-ply, stainless-steel bellows isolated from fluid flow by an internal pipe sleeve.
 - b. Carbon-steel housing.
 - c. Drain plugs and lifting lug for NPS 3 and larger.
 - d. Bellows shall have operating clearance between the internal pipe sleeves and the external shrouds.
 - e. Joints shall be supplied with a built-in scale to confirm the starting position and operating movement.
 - f. Joint Axial Movement: 4 inches, 6 inches, 8 inches of compression and 0.75 inch, 1 inch, 2 inches of extension as required.
 4. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are not acceptable.
 5. End Connection Configuration: Flanged; one raised, fixed and one floating flange.
- E. Rubber Packless Expansion Joints REJ-01:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Flex-Hose Co., Inc.
 - b. Mason Industries, Inc.

- c. Metraflex Company (The).
- d. Unaflex.
2. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
3. Material: Fabric-reinforced rubber complying with FSA-PSJ-703.
4. Arch Type: Single or multiple arches with external control rods.
5. Spherical Type: Single or multiple spheres with external control rods.
6. Minimum Pressure Rating for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.
7. Minimum Pressure Rating for NPS 5 and NPS 6: 140 psig at 200 deg F.
8. Minimum Pressure Rating for NPS 8 to NPS 12: 140 psig at 180 deg F.
9. Material for Fluids Containing Acids, Alkalis, or Chemicals: Butyl rubber, Chlorosulfonyl-polyethylene rubber or Ethylene-propylene-diene terpolymer rubber.
10. Material for Fluids Containing Gas, Hydrocarbons, or Oil: Buna-N or Chlorosulfonated polyethylene synthetic rubber.
11. Material for Water: Butyl rubber, Buna-N, Chlorosulfonated polyethylene synthetic rubber, Chlorosulfonyl-polyethylene rubber, Ethylene-propylene-diene terpolymer rubber or Natural rubber.
12. End Connections: Full-faced, integral steel flanges with steel retaining rings.

2.3 GROOVED-JOINT EXPANSION JOINTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Anvil International.
 2. Shurjoint Piping Products USA Inc.
 3. Victaulic Company.
- B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
- C. Standard: AWWA C606, for grooved joints.
- D. Nipples: Galvanized, ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.
- E. Couplings: Five to twelve, flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid, alkaline fluids, and cold and hot water, Ethylene-propylene-diene terpolymer rubber gasket suitable for cold and hot water, and bolts and nuts.

2.4 ALIGNMENT GUIDES AND ANCHORS

- A. Alignment Guides AG-01:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Flex-Weld, Inc.
 - d. Mason Industries, Inc.
 - e. U.S. Bellows, Inc.
 2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.
- B. Anchor Materials:
 1. Steel Shapes and Plates: ASTM A 36/A 36M.
 2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
 3. Washers: ASTM F 844, steel, plain, flat washers.
 4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Stud: Threaded, zinc-coated carbon steel.



- b. Expansion Plug: Zinc-coated steel.
- c. Washer and Nut: Zinc-coated steel.
- 5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 - c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION JOINT INSTALLATION

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- C. Install rubber packless expansion joints according to FSA-PSJ-703.
- D. Install grooved-joint expansion joints to grooved-end steel piping.

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install one or two guides on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
 - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 22 05 16

SECTION 22 05 17
SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.
 - 6. Silicone sealants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. GPT; an EnPro Industries company.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.
- C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, anticorrosion coated or galvanized, with plain ends and integral welded waterstop collar.
- D. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- E. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
- F. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- G. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Jay R. Smith Mfg. Co.
 - 2. Zurn Industries, LLC.
- B. Description: Manufactured, Dura-coated or Duco-coated cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.



2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Proco Products, Inc.
- B. Description:
 - 1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 2. Designed to form a hydrostatic seal of 20 psig minimum.
 - 3. Sealing Elements: EPDM-rubber, High-temperature-silicone or Nitrile Buna N interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 4. Pressure Plates: Carbon steel, Stainless steel, Type 316.
 - 5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B 633, Stainless steel, Type 316 of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Proco Products, Inc.
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.
- C. Plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.6 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Dow Corning Corporation.
 - b. Polymeric Systems, Inc.
 - c. Sherwin-Williams Company (The).
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. May National Associates, Inc.; a subsidiary of Sika Corporation.

- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Smooth-On.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."
- F. Sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Use silicone sealant to seal the space around outside of stack-sleeve fittings.
- B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Use grout or silicone sealant to seal the space around outside of sleeve-seal fittings.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves, Steel pipe sleeves or Sleeve-seal fittings.
 - b. Piping NPS 6 and Larger: Cast-iron pipe sleeves, Steel pipe sleeves or Sleeve-seal fittings.
 - 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system, Steel pipe sleeves with sleeve-seal system or Sleeve-seal fittings.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system, Steel pipe sleeves with sleeve-seal system or Sleeve-seal fittings.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system, Steel pipe sleeves with sleeve-seal system or Sleeve-seal fittings.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system, Steel pipe sleeves with sleeve-seal system or Sleeve-seal fittings.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves, PVC pipe sleeves, Stack-sleeve fittings, Sleeve-seal fittings, Molded-PE or -PP sleeves or Molded-PVC sleeves.
 - b. Piping NPS 6 and Larger: Steel pipe sleeves, PVC pipe sleeves or Stack-sleeve fittings.



5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves or PVC pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION 22 05 17

SECTION 22 05 18
ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed and salvaged, or removed and reinstalled.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. BrassCraft Manufacturing Co.; a Masco company.
 - 2. Dearborn Brass.
 - 3. Keeney Manufacturing Company (The).
 - 4. ProFlo; a Ferguson Enterprises, Inc. brand.

2.2 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.
- C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel or brass with polished, chrome-plated finish and spring-clip fasteners.
- E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed or exposed-rivet hinge; and spring-clip fasteners.

2.3 FLOOR PLATES

- A. Split Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping and Relocated Existing Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Chrome-Plated Piping: One-piece steel or split-casting brass with polished, chrome-plated finish.

- c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
 - d. Insulated Piping: One-piece stainless steel with polished stainless-steel finish.
 - e. Insulated Piping: One-piece cast brass with polished, chrome-plated finish.
 - f. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - g. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
 - h. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
 - i. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
 - j. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - k. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
 - l. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
 - m. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
 - n. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - o. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
 - p. Bare Piping in Unfinished Service Spaces: One-piece cast brass with polished, chrome-plated finish.
 - q. Bare Piping in Unfinished Service Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - r. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.
 - s. Bare Piping in Equipment Rooms: One-piece cast brass with polished, chrome-plated finish.
 - t. Bare Piping in Equipment Rooms: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
2. Escutcheons for Existing Piping to Remain:
- a. Chrome-Plated Piping: Split-casting, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- 1. New Piping and Relocated Existing Piping: One-piece, floor plate.
 - 2. Existing Piping: Split floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.



END OF SECTION 22 05 18



**SECTION 22 05 19
METERS AND GAGES FOR PLUMBING PIPING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Bimetallic-actuated thermometers.
 - 2. Filled-system thermometers.
 - 3. Liquid-in-glass thermometers.
 - 4. Thermowells.
 - 5. Dial-type pressure gages.
 - 6. Gage attachments.
 - 7. Test plugs.
 - 8. Test-plug kits.
- B. Related Requirements:
 - 1. Section 22 11 19 "Domestic Water Piping Specialties" for water meters.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Ashcroft Inc.
 - 2. Terice, H. O. Co.
 - 3. Weiss Instruments, Inc.
 - 4. Weksler Glass Thermometer Corp.
- B. Standard: ASME B40.200.
- C. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch to 5-inch nominal diameter.
- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
- E. Connector Type(s): Union joint, adjustable angle, rigid, back, and/or rigid, bottom, with unified-inch screw threads.
- F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
- G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- H. Window: Plain glass or plastic.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.

- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus 1 percent of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

- A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ashcroft Inc.
 - b. Palmer Wahl Instrumentation Group.
 - c. Terice, H. O. Co.
 - d. Weiss Instruments, Inc.
 - 2. Standard: ASME B40.200.
 - 3. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch to 6-inch nominal diameter.
 - 4. Element: Bourdon tube or other type of pressure element.
 - 5. Movement: Mechanical, with link to pressure element and connection to pointer.
 - 6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 7. Pointer: Dark-colored metal.
 - 8. Window: Glass or plastic.
 - 9. Ring: Metal or Stainless steel.
 - 10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device or with rigid back and bottom; with ASME B1.1 screw threads.
 - 11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
 - 12. Accuracy: Plus or minus 1 percent of scale range.

2.3 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Terice, H. O. Co.
 - 2. Standard: ASME B40.200.
 - 3. Case: Cast aluminum; 6-inch nominal size.
 - 4. Case Form: Back angle or Straight unless otherwise indicated.
 - 5. Tube: Glass with magnifying lens and blue or red organic liquid.
 - 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 7. Window: Glass or plastic.
 - 8. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
 - 9. Connector: 3/4 inch, with ASME B1.1 screw threads.
 - 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.4 THERMOWELLS

- A. Thermowells:
 - 1. Standard: ASME B40.200.
 - 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 - 3. Material for Use with Copper Tubing: CNR or CUNI.
 - 4. Material for Use with Steel Piping: CRES or CSA.
 - 5. Type: Stepped shank unless straight or tapered shank is indicated.

6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.5 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ametek U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Terrice, H. O. Co.
 - d. Weiss Instruments, Inc.
2. Standard: ASME B40.100.
3. Case: Liquid-filled or Sealed, Open-front or Solid-front, pressure relief type(s); cast aluminum or drawn steel; 4-1/2-inch to 6-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Ring: Metal, Brass or Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.6 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.7 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Flow Design, Inc.
 2. Terrice, H. O. Co.
 3. Weiss Instruments, Inc.
 4. Weksler Glass Thermometer Corp.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.8 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Flow Design, Inc.
 - 2. Sisco Manufacturing Company, Inc.
 - 3. Trerice, H. O. Co.
 - 4. Weiss Instruments, Inc.
- B. Furnish one test-plug kit containing one thermometer, one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
- D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- F. Carrying Case: Metal or plastic, with formed instrument padding.

2.9 SIGHT FLOW INDICATORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. ARCHON Industries, Inc.
 - 2. Emerson Process Management; Rosemount Division.
 - 3. Ernst Flow Industries.
 - 4. Pentair Valves & Controls; Penberthy Brand.
- B. Description: Piping inline-installation device for visual verification of flow.
- C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
- D. Minimum Pressure Rating: 125 psig or 150 psig.
- E. Minimum Temperature Rating: 200 deg F.
- F. End Connections for NPS 2 and Smaller: Threaded.
- G. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending a minimum of 2 inches into fluid, one-third of pipe diameter or to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

- H. Install remote-mounted pressure gages on panel.
- I. Install valve and snubber in piping for each pressure gage for fluids.
- J. Install test plugs in piping tees.
- K. Install thermometers in the following locations:
 - 1. Inlet and outlet of each water heater.
 - 2. Inlets and outlets of each domestic water heat exchanger.
 - 3. Inlet and outlet of each domestic hot-water storage tank.
 - 4. Inlet and outlet of each remote domestic water chiller.
 - 5. Inlet and outlet of domestic hot water recirculation system.
- L. Install pressure gages in the following locations:
 - 1. Building water service entrance into building.
 - 2. Inlet and outlet of each pressure-reducing valve.
 - 3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each domestic water heater shall be **one of** the following:
 - 1. Liquid-filled or Sealed, bimetallic-actuated type.
 - 2. Direct-mounted, metal or plastic-case, vapor-actuated type.
 - 3. Metal or Plastic case, compact-style, liquid-in-glass type.
 - 4. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.
- B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be **one of** the following:
 - 1. Liquid-filled or Sealed, bimetallic-actuated type.
 - 2. Direct-mounted, metal or plastic-case, vapor-actuated type.
 - 3. Metal or Plastic case, compact-style, liquid-in-glass type.
 - 4. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.
- C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be **one of** the following:
 - 1. Liquid-filled or Sealed, bimetallic-actuated type.
 - 2. Direct-mounted, metal or plastic-case, vapor-actuated type.
 - 3. Metal or Plastic case, compact-style, liquid-in-glass type.
 - 4. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.
- D. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F.
- B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F.

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each water service into building shall be one of the following:
 - 1. Liquid-filled or Sealed, Open-front, pressure-relief or Solid-front, pressure-relief type, direct-mounted, metal case.
 - 2. Sealed, direct-mounted, plastic case.
 - 3. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.



- B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
 - 1. Liquid-filled or Sealed, Open-front, pressure-relief or Solid-front, pressure-relief type, direct-mounted, metal case.
 - 2. Sealed, direct-mounted, plastic case.
 - 3. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.
- C. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
 - 1. Liquid-filled or Sealed, Open-front, pressure-relief or Solid-front, pressure-relief type, direct-mounted, metal case.
 - 2. Sealed, direct-mounted, plastic case.
 - 3. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Water Piping: 0 to 200 psi.

END OF SECTION 22 05 19

**SECTION 22 05 23
GENERAL DUTY VALVES FOR PLUMBING PIPING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Brass ball valves.
 - 2. Bronze ball valves.
 - 3. Bronze lift check valves.
 - 4. Bronze swing check valves.
 - 5. Bronze gate valves.
 - 6. Iron, single-flange butterfly valves.
 - 7. Iron, grooved-end butterfly valves.
 - 8. Chainwheels.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and soldered ends.
 - 3. Protect threads, flange faces, grooves, and weld ends.
 - 4. Set ball valves open to minimize exposure of functional surfaces.
 - 5. Set check valves in either closed or open position.
 - 6. Set gate valves closed to prevent rattling.
 - 7. Set butterfly valves closed or slightly open.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.5 for flanges on steel valves.
 - 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 5. ASME B16.18 for solder-joint connections.
 - 6. ASME B31.9 for building services piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- G. RS Valves in Insulated Piping: With 2-inch stem extensions.
- H. Valve Sizes: Same as upstream piping unless otherwise indicated.
- I. Valve Bypass and Drain Connections: MSS SP-45.
- J. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handlever: For quarter-turn valves smaller than NPS 6.
 - 3. Chainwheel: Device for attachment to gear, handlever, or stem; of size and with chain for mounting height, according to "Valve Installation" Article.
- K. Valves in Insulated Piping:
 - 1. Include 2-inch stem extensions.
 - 2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRASS BALL VALVES

- A. Brass Ball Valves, One-Piece:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. KITZ Corporation.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig.
 - c. Body Design: One piece.
 - d. Body Material: Forged brass or bronze.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Brass or stainless steel.
 - h. Ball: Chrome-plated brass or stainless steel.
 - i. Port: Reduced.
- B. Brass Ball Valves, Two-Piece with Full Port and Brass Trim, Threaded or Soldered Ends:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. FNW; Ferguson Enterprises, Inc.
 - c. KITZ Corporation.

- d. NIBCO INC.
- e. Red White Valve Corp.
- 2. Description:
 - a. Standard: MSS SP-110 or MSS SP-145.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Forged brass.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.
- C. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim, Threaded or Soldered Ends:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. KITZ Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110 or MSS SP-145.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Forged brass.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Full.
- D. Brass Ball Valves, Two-Piece with Regular Port and Brass Trim:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. FNW; Ferguson Enterprises, Inc.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Forged brass.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Regular.
- E. Brass Ball Valves, Two-Piece with Regular Port and Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:



- a. Apollo Flow Controls; Conbraco Industries, Inc.
- b. FNW; Ferguson Enterprises, Inc.
- c. Milwaukee Valve Company.
- d. NIBCO INC.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Brass or bronze.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Regular.
- F. Brass Ball Valves, Three-Piece with Full Port and Brass Trim:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jomar Valve.
 - b. KITZ Corporation.
 - c. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Three piece.
 - d. Body Material: Forged brass.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.
- G. Brass Ball Valves, Three-Piece with Full Port and Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Marwin Valve; Richards Industries.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Three piece.
 - d. Body Material: Forged brass.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Full.

2.3 BRONZE BALL VALVES

- A. Bronze Ball Valves, One-Piece with Bronze Trim:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.

- b. FNW; Ferguson Enterprises, Inc.
- c. NIBCO INC.
- d. WATTS.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig.
 - c. Body Design: One piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Bronze.
 - h. Ball: Chrome-plated brass.
 - i. Port: Reduced.
- B. Bronze Ball Valves, One-Piece with Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. NIBCO INC.
 - c. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: One piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Reduced.
- C. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim, Threaded or Soldered Ends:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. FNW; Ferguson Enterprises, Inc.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110 or MSS-145.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Bronze or brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.
- D. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim, Press Ends:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. WATTS.
2. Description:
 - a. Standard: MSS SP-110 or MSS-145.
 - b. CWP Rating: Minimum 200 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Press.
 - f. Press Ends Connections Rating: Minimum 200 psig.
 - g. Seats: PTFE or RTPFE.
 - h. Stem: Bronze or brass.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.
 - k. O-Ring Seal: EPDM or Buna-N.
- E. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. FNW; Ferguson Enterprises, Inc.
 - c. NIBCO INC.
 - d. WATTS.
 2. Description:
 - a. Standard: MSS SP-110 or MSS-145.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded or soldered.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Full.
- F. Bronze Ball Valves, Two-Piece with Regular Port and Bronze or Brass Trim:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. WATTS.
 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Bronze or brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Regular.



- G. Bronze Ball Valves, Two-Piece with Regular Port and Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Hammond Valve.
 - c. NIBCO INC.
 - d. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Regular.
- H. Bronze Ball Valves, Three-Piece with Full Port and Bronze or Brass Trim:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Three piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Bronze or brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.
- I. Bronze Ball Valves, Three-Piece with Full Port and Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Three piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.

- i. Port: Full.
- J. Bronze Ball Valves, Three-Piece with Regular Port and Bronze Trim:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Jamesbury; Metso.
 - c. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Three piece
 - d. Body Material: Bronze
 - e. Ends: Threaded or soldered.
 - f. Seats: PTFE.
 - g. Stem: Bronze.
 - h. Ball: Chrome-plated brass.
 - i. Port: Regular.
- K. Bronze Ball Valves, Three-Piece with Regular Port and Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Jamesbury; Metso.
 - c. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Three piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded or soldered.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Regular.
- L. Bronze Ball Valves, Two-Piece, Safety-Exhaust:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Jamesbury; Metso.
 - c. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze, ASTM B 584, Alloy C844.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Chrome-plated brass, with exhaust vent opening for pneumatic applications.
 - i. Port: Full.

2.4 BRONZE LIFT CHECK VALVES

- A. Bronze Lift Check Valves with Bronze Disc, Class 125:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Crane; Crane Energy Flow Solutions.
 - b. Jenkins Valves; Crane Energy Flow Solutions.
 - c. Stockham; Crane Energy Flow Solutions.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.
- B. Bronze Lift Check Valves with Nonmetallic Disc, Class 125:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. KITZ Corporation.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: NBR, PTFE.

2.5 BRONZE SWING CHECK VALVES

- A. Bronze Swing Check Valves with Bronze Disc, Class 125:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. KITZ Corporation.
 - c. NIBCO INC.
 - d. Stockham; Crane Energy Flow Solutions.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.
- B. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Crane; Crane Energy Flow Solutions.
 - c. KITZ Corporation.

- d. NIBCO INC.
- 2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: PTFE.
- C. Bronze Swing Check Valves with Bronze Disc, Class 150:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Crane; Crane Energy Flow Solutions.
 - c. KITZ Corporation.
 - d. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.
- D. Bronze Swing Check Valves with Nonmetallic Disc, Class 150:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Crane; Crane Energy Flow Solutions.
 - b. FNW; Ferguson Enterprises, Inc.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: PTFE.

2.6 BRONZE GATE VALVES

- A. Bronze Gate Valves, NRS, Class 125:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. FNW; Ferguson Enterprises, Inc.
 - c. KITZ Corporation.
 - d. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: Bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.



- e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.
- B. Bronze Gate Valves, RS, Class 125:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. FNW; Ferguson Enterprises, Inc.
 - c. KITZ Corporation.
 - d. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: Bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.
- C. Bronze Gate Valves, NRS, Class 150:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. KITZ Corporation.
 - c. NIBCO INC.
 - d. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 300 psig.
 - c. Body Material: Bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.
- D. Bronze Gate Valves, RS, Class 150:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. KITZ Corporation.
 - c. NIBCO INC.
 - d. WATTS.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: Bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.

- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

2.7 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. KITZ Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM or NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
- B. Iron, Single-Flange Butterfly Valves with Ductile-Iron Disc:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. KITZ Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM or NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Nickel-plated or nickel-coated ductile iron.
- C. Iron, Single-Flange Butterfly Valves with Stainless-Steel Disc:
 - 1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
 - 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. KITZ Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - 3. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating, NPS 12 and Smaller: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.

- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM or NBR.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Stainless steel.

2.8 DUCTILE-IRON, GROOVED-END BUTTERFLY VALVES

- A. Ductile Iron, Grooved-End Butterfly Valves, 175 CWP:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Kennedy Valve Company; a division of McWane, Inc.
 - b. Tyco Fire Products LP.
 - c. Victaulic Company.
 - d. Zurn Industries, LLC.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 175 psig.
 - c. Body Material: Coated, ductile iron.
 - d. Stem: Two-piece stainless steel.
 - e. Disc: Coated, ductile iron.
 - f. Seal: EPDM.
- B. Ductile Iron, Grooved-End Butterfly Valves, 300 CWP:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Mueller Steam Specialty; A WATTS Brand.
 - b. NIBCO INC.
 - c. Tyco Fire Products LP.
 - d. Victaulic Company.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating, NPS 8 and Smaller: 300 psig.
 - c. CWP Rating, NPS 10 and Larger: 200 psig.
 - d. Body Material: Coated, ductile iron.
 - e. Stem: Two-piece stainless steel.
 - f. Disc: Coated, ductile iron.
 - g. Seal: EPDM or NBR.

2.9 CHAINWHEELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Babbitt Steam Specialty Co.
 - 2. Roto Hammer Industries.
 - 3. Trumbull Industries.
- B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to handwheels.
 - 1. Sprocket Rim with Chain Guides: Ductile or cast iron, Aluminum or Bronze, of type and size required for valve. Include zinc or epoxy coating.
 - 2. Chain: Hot-dip, galvanized steel, Brass or Stainless steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
- F. Check Valves: Install check valves for proper direction of flow.
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.
 - a. Install chainwheels on operators for gate valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- G. All restrooms to have stand-alone isolation valves for hot and cold water for future offline service.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If ball valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Grooved-End Copper Tubing and Steel Piping: Grooved.
- C. If check valve applications are not indicated, use the following:
 - 1. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; or iron, center-guided, metal-seat or resilient-seat check valves.



- c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

D. Use gate valves for shutoff service only.

3.5 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Brass ball valves, one piece.
3. Bronze ball valves, one piece with bronze or stainless steel trim.
4. Brass ball valves, two-piece with full-port and brass or stainless steel trim.
5. Bronze ball valves, two-piece with full-port and bronze, brass or stainless steel trim.
6. Brass ball valves, three-piece with full port and brass or stainless steel trim.
7. Bronze ball valve, three-piece with full port and bronze, brass or stainless steel trim.
8. Bronze ball valves, two-piece with regular port and bronze or stainless steel trim.
9. Vertical, Upflow Applications Only: Bronze lift check valves with bronze disc, Class 125, with soldered or threaded end connections.
10. Horizontal and Vertical Applications: Bronze swing check valves with bronze disc, Class 125 or Class 150, with soldered or threaded end connections.
11. Bronze gate valves, NRS, RS, Class 125 or Class 150 with soldered or threaded ends.

B. Pipe NPS 2-1/2 and Larger:

1. Steel and Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Steel ball valves, Class 150 with full-port.
3. Iron ball valves, Class 150.
4. Iron swing check valves with metal seats, Class 125 or Class 250, with threaded or flanged end connections.
5. Iron, grooved-end swing check valves, 300 CWP.
6. Iron, dual-plate check valves with metal, resilient seat, Class 125, Class 150, Class 250 or Class 300, with threaded or flanged end connections.
7. Iron, single-plate check valves with resilient seat, Class 125 or Class 250, with threaded or flanged end connections.
8. Iron gate valves, NRS, OS&Y, Class 125 or Class 150 with flanged ends.
9. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, aluminum-bronze, ductile-iron or stainless-steel disc.
10. Ductile-Iron, Grooved-End Butterfly Valves: 175 or 300 CWP.

3.6 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 TO 200 PSIG)

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Brass ball valve.
3. Bronze ball valve, one piece with bronze or stainless steel trim.
4. Brass ball valves, two-piece with full-port and brass or stainless steel trim.
5. Bronze ball valves, two-piece with full-port and bronze, brass or stainless steel trim.
6. Brass ball valves, three-piece with full port and brass or stainless steel trim.
7. Bronze ball valves, three-piece with full port and bronze, brass or stainless steel trim.
8. Bronze ball valves, two-piece with regular port and bronze or stainless steel trim.
9. Vertical, Upflow Applications Only: Bronze lift check valves with bronze disc, Class 125, with soldered or threaded end connections.
10. Horizontal and Vertical Applications: Bronze swing check valves with bronze disc, Class 125 or Class 150, with soldered or threaded end connections.
11. Bronze gate valves NRS, RS, Class 125 or Class 150 with soldered or threaded ends.

- B. Pipe NPS 2-1/2 and Larger:
1. Steel and Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 2. Steel ball valves, Class 150 with full-port.
 3. Iron ball valves, Class 150.
 4. Iron swing check valves with metal seats, Class 125 or Class 250, with threaded or flanged end connections.
 5. Iron, grooved-end swing check valves, 300 CWP with threaded or flanged end connections.
 6. Iron, dual-plate check valves with metal, resilient seat, Class 125, Class 150, Class 250 or Class 300, with threaded or flanged end connections.
 7. Iron, single-plate check valves with resilient seat, Class 125 or Class 250, with threaded or flanged end connections.
 8. Iron gate valves, NRS, OS&Y, Class 125 or Class 250 with flanged ends.
 9. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, aluminum-bronze, ductile-iron or stainless-steel disc.
 10. Ductile-Iron, Grooved-End Butterfly Valves: 175 or 300 CWP.

3.7 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
1. Brass ball valve, one piece. Provide with threaded or solder-joint ends.
 2. Bronze ball valve, one piece with bronze or stainless steel trim. Provide with threaded or solder-joint ends.
 3. Brass ball valves, two-piece with full-port and brass or stainless steel trim. Provide with threaded or solder-joint ends.
 4. Bronze ball valves, two-piece with full-port and bronze, brass or stainless steel trim. Provide with threaded or solder-joint ends.
 5. Brass ball valves, three-piece with full port and brass or stainless steel trim.
 6. Bronze ball valves, three-piece with full port and bronze, brass or stainless steel trim.
 7. Bronze ball valves, two-piece with regular port and bronze or stainless-steel trim.
 8. Bronze swing check valves with bronze disc, Class 125 or Class 150, with soldered or threaded end connections.
 9. Bronze gate valves, NRS, RS, Class 125 or Class 150 with soldered or threaded ends.
- B. Pipe NPS 2-1/2 and Larger:
1. Steel and Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 2. Steel ball valves, Class 150 with full-port.
 3. Iron ball valves, Class 150.
 4. Iron swing check valves with metal seats, Class 125 or Class 250, with threaded or flanged end connections.
 5. Iron swing check valves with closure control lever and spring or weight, Class 125, with threaded or flanged end connections.
 6. Iron, grooved-end swing check valves, 300 CWP.
 7. Iron, center-guided check valves with compact wafer, Class 125, Class 150, Class 250 or Class 300.
 8. Iron, center-guided check valves with globe, metal, resilient seat, Class 125, Class 150, Class 250 or Class 300, with threaded or flanged end connections.
 9. Iron, dual-plate check valves with metal, resilient seat, Class 125, Class 150, Class 250 or Class 300, with threaded or flanged end connections.
 10. Iron, single-plate check valves with resilient seat, Class 125 or Class 250, with threaded or flanged end connections.
 11. Iron gate valves, NRS, OS&Y, Class 125 or Class 250 with flanged ends.



12. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM or NBR seat, aluminum-bronze, ductile-iron or stainless-steel disc.
13. Ductile-Iron, Grooved-End Butterfly Valves: 175 or 300 CWP.

END OF SECTION 22 05 23

SECTION 22 05 29
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal hanger-shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Pipe-positioning systems.
 - 8. Equipment supports.
- B. Related Requirements:
 - 1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Section 22 05 16 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
 - 3. Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Pipe stands.
 - 4. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
 - 3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
- B. Stainless-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- C. Copper Pipe and Tube Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. B-line, an Eaton business.
 - b. Flex-Strut Inc.
 - c. G-Strut.
 - d. Unistrut; Part of Atkore International.
 - 2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
 - 3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 4. Channels: Continuous slotted carbon-steel, stainless-steel, Type 304, stainless-steel, Type 316 or extruded-aluminum channel with inturned lips.
 - 5. Channel Width: Selected for applicable load criteria.
 - 6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.



7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
 8. Metallic Coating: Pregalvanized G90, Electroplated zinc, Hot-dip galvanized or Gold (yellow zinc dichromate) galvanized.
 9. Paint Coating: Green epoxy, acrylic, or urethane.
 10. Plastic Coating: PVC.
- B. Non-MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Anvil International.
 - b. ERICO International Corporation.
 - c. MIRO Industries, Inc.
 - d. PHD Manufacturing, Inc.
 2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
 3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
 4. Channels: Continuous slotted carbon-steel or Stainless-steel channel with inturned lips.
 5. Channel Width: Select for applicable load criteria.
 6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
 8. Metallic Coating: Pregalvanized G90 or Hot-dip galvanized.
 9. Paint Coating: Green epoxy, acrylic, or urethane.
 10. Plastic Coating: PVC.

2.5 THERMAL HANGER-SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Carpenter & Paterson, Inc.
 2. ERICO International Corporation.
 3. Pipe Shields Inc.
 4. Piping Technology & Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate with 100-psig, ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC.

- d. Simpson Strong-Tie Co., Inc.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. B-line, an Eaton business.
 - b. Empire Tool and Manufacturing Co., Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 2. Indoor Applications: Zinc-coated or stainless steel.
 - 3. Outdoor Applications: Stainless steel.

2.7 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand:
 - 1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 - 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 - 3. Hardware: Galvanized steel or polycarbonate.
 - 4. Accessories: Protection pads.
- C. Low-Profile, Single-Base, Single-Pipe Stand:
 - 1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
 - 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 - 3. Vertical Members: Two galvanized or stainless-steel, continuous-thread, 1/2-inch rods.
 - 4. Horizontal Member: Adjustable horizontal, galvanized or stainless-steel pipe support channels.
 - 5. Pipe Supports: Strut clamps, Clevis hanger or Swivel hanger.
 - 6. Hardware: Galvanized or Stainless steel.
 - 7. Accessories: Protection pads.
 - 8. Height: 12 inches above roof.
- D. High-Profile, Single-Base, Single-Pipe Stand:
 - 1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Single vulcanized rubber or molded polypropylene.
 - 3. Vertical Members: Two galvanized or stainless-steel, continuous-thread, 1/2-inch rods.
 - 4. Horizontal Member: One adjustable-height, galvanized or stainless-steel, pipe-support slotted channel or plate.
 - 5. Pipe Supports: Clevis hanger or Swivel hanger.
 - 6. Hardware: Galvanized or Stainless steel.
 - 7. Accessories: Protection pads, 1/2-inch, continuous-thread, galvanized-steel rod or continuous-thread, stainless-steel rod.
 - 8. Height: 36 inches above roof.
- E. High-Profile, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: Two or more; vulcanized rubber or molded polypropylene.
 - 3. Vertical Members: Two or more, galvanized or stainless-steel channels.
 - 4. Horizontal Members: One or more, adjustable-height, galvanized or stainless-steel pipe support.

5. Pipe Supports: Strut clamps, Clevis hanger or Swivel hanger.
6. Hardware: Galvanized or Stainless steel.
7. Accessories: Protection pads, 1/2-inch, continuous-thread rod.
8. Height: 36 inches above roof.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.8 PIPE-POSITIONING SYSTEMS

A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.9 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.10 MATERIALS

- A. Aluminum: ASTM B 221.
- B. Carbon Steel: ASTM A 1011/A 1011M.
- C. Structural Steel: ASTM A 36/A 36M carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A 240/A 240M.
- E. Grout: ASTM C 1107/C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.



2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- G. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- O. Insulated Piping:
 1. Attach clamps and spacers to piping.
 - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in specification division 09.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A 780/A 780M.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.

- I. Use thermal hanger-shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F. pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 - 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
 - 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
 - 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
 - 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
 - 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 - 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
 - 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 - 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 - 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 - 6. C-Clamps (MSS Type 23): For structural shapes.
 - 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 - 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 - 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 - 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 - 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 - 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 - 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 - 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 - 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 - 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 - 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.



4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- S. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29

SECTION 22 05 48
VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Elastomeric isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Open-spring isolators.
 - 5. Housed-spring isolators.
 - 6. Restrained-spring isolators.
 - 7. Housed-restrained-spring isolators.
 - 8. Pipe-riser resilient supports.
 - 9. Resilient pipe guides.
 - 10. Elastomeric hangers.
 - 11. Spring hangers.
 - 12. Snubbers.
 - 13. Restraint channel bracings.
 - 14. Restraint cables.
 - 15. Seismic-restraint accessories.
 - 16. Mechanical anchor bolts.
 - 17. Adhesive anchor bolts.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning & Development (for the State of California).

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES, OSHPD or an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 - 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
 - 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment.
- C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
 - 1. Include design calculations and details for selecting vibration isolators and seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

2. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, due to seismic forces required to select vibration isolators, and due to seismic restraints.
3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, OSHPD or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For testing agency.
- C. Welding certificates.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 1. Site Class as Defined in the IBC: A, B, C, D, E or F.
 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: I, II or III.
 - a. Component Importance Factor: 1.0 or 1.5 or per project specifics.
 - b. Component Response Modification Factor: 1.5, 2.5, 3.5 or 5.0.

- c. Component Amplification Factor: 1.0 or 2.5.
3. Design Spectral Response Acceleration at Short Periods (0.2 Second):
4. Design Spectral Response Acceleration at 1.0-Second Period:
5. Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES, OSHPD or an agency acceptable to authorities having jurisdiction.
 - a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they are subjected.

2.2 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Kinetics Noise Control, Inc.
 - d. Mason Industries, Inc.
 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 3. Size: Factory or field cut to match requirements of supported equipment.
 4. Pad Material: Oil and water resistant with elastomeric properties.
 5. Surface Pattern: Smooth, Ribbed or Waffle pattern.
 6. Infused nonwoven cotton or synthetic fibers.
 7. Load-bearing metal plates adhered to pads.
 8. Sandwich-Core Material: Resilient and elastomeric.
 - a. Surface Pattern: Smooth, Ribbed or Waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Kinetics Noise Control, Inc.
 - d. Mason Industries, Inc.
 2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
 3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

- A. Restrained Elastomeric Isolation Mounts:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Kinetics Noise Control, Inc.
 - d. Mason Industries, Inc.

2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Kinetics Noise Control, Inc.
 - d. Mason Industries, Inc.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
 7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 HOUSED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Kinetics Noise Control, Inc.
 - d. Mason Industries, Inc.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top housing with threaded mounting holes and internal leveling device.

2.7 RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Kinetics Noise Control, Inc.



- d. Mason Industries, Inc.
- 2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top plate with threaded mounting holes or elastomeric pad.
 - c. Internal leveling bolt that acts as blocking during installation.
- 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
- 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- 5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
- 6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- 7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Kinetics Noise Control, Inc.
 - d. Mason Industries, Inc.
 - 2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch thick neoprene.
 - 1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 - 2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.10 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch thick neoprene.
 - 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.11 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:



1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Kinetics Noise Control, Inc.
 - d. Mason Industries, Inc.
2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.12 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Kinetics Noise Control, Inc.
 - d. Mason Industries, Inc.
 2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.13 SNUBBERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Kinetics Noise Control, Inc.
 2. Mason Industries, Inc.
 3. Novia; A Division of C&P.
 4. Vibration Mountings & Controls, Inc.
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum 1/4-inch air gap, and minimum 1/4-inch thick resilient cushion.

2.14 RESTRAINT CHANNEL BRACINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. B-line, an Eaton business.
 2. Hilti, Inc.



3. Mason Industries, Inc.
 4. Unistrut; Part of Atkore International.
- B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.15 RESTRAINT CABLES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Gripple Inc.
 2. Kinetics Noise Control, Inc.
 3. Mason Industries, Inc.
 4. Vibration & Seismic Technologies, LLC.
- B. Restraint Cables: ASTM A 603 galvanized and/or ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.16 SEISMIC-RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. B-line, an Eaton business.
 2. Kinetics Noise Control, Inc.
 3. Mason Industries, Inc.
 4. TOLCO.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.17 MECHANICAL ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. B-line, an Eaton business.
 2. Hilti, Inc.
 3. Kinetics Noise Control, Inc.
 4. Mason Industries, Inc.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.18 ADHESIVE ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Hilti, Inc.
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries, Inc.
- B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES, OSHPD or an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in specification division 03.
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- D. Equipment Restraints:
 - 1. Install seismic snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES, OSHPD or an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- E. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- F. Install cables so they do not bend across edges of adjacent equipment or building structure.

- G. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES, OSHPD or an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- H. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- I. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- J. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- K. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing steel or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 221116 "Domestic Water Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.



3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION 22 05 48

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Brady Corporation.
 - b. Craftmark Pipe Markers.
 - c. Kolbi Pipe Marker Co.
 - d. Seton Identification Products.
 - 2. Material and Thickness: Brass, 0.032-inch, stainless steel, 0.025-inch, aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 3. Letter Color: White.
 - 4. Background Color: Black.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:



- a. Brady Corporation.
 - b. Craftmark Pipe Markers.
 - c. Kolbi Pipe Marker Co.
 - d. Seton Identification Products.
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 3. Letter Color: White.
 4. Background Color: Black.
 5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 8. Fasteners: Stainless-steel rivets or self-tapping screws.
 9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Brady Corporation.
 2. Craftmark Pipe Markers.
 3. Marking Sevcies Inc.
 4. Seton Identification Products.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: White.
- D. Background Color: Black.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Brady Corporation.

2. Craftmark Pipe Markers.
 3. Kolbi Pipe Marker Co.
 4. Seton Identification Products.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: Size letters according to ASME A13.1 for piping, At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.4 STENCILS

- A. Stencils for Piping:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Brimar Industries, Inc.
 - b. Craftmark Pipe Markers.
 - c. Kolbi Pipe Marker Co.
 - d. Marking Services Inc.
 2. Lettering Size: Size letters according to ASME A13.1 for piping, At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
 3. Stencil Material: Aluminum, Brass, Fiberboard or metal.
 4. Stencil Paint: Exterior, gloss, alkyd enamel or acrylic enamel paint type in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
 5. Identification Paint: Exterior, alkyd enamel or acrylic enamel paint type in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Brady Corporation.
 2. Craftmark Pipe Markers.
 3. Kolbi Pipe Marker Co.
 4. Seton Identification Products.
- B. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
1. Tag Material: Brass, 0.032-inch, stainless steel, 0.025-inch, aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link chain or beaded chain.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Brady Corporation.
 - 2. Craftmark Pipe Markers.
 - 3. Kolbi Pipe Marker Co.
 - 4. Seton Identification Products.
- B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7 inches.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting." or Section 099600 "High-Performance Coatings."
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.



- D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- E. Pipe Label Color Schedule:
 - 1. Low-Pressure Compressed Air Piping:
 - a. Background: Safety blue.
 - b. Letter Colors: White.
 - 2. High-Pressure Compressed Air Piping:
 - a. Background: Safety blue.
 - b. Letter Colors: White.
 - 3. Domestic Water Piping
 - a. Background: Safety green.
 - b. Letter Colors: White.
 - 4. Natural Gas Piping
 - a. Background: Safety yellow.
 - b. Letter Colors: Black.
 - 5. Sanitary Waste, Vent and Storm Drainage Piping:
 - a. Background Color: Safety green.
 - b. Letter Color: White.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Domestic Water: 1-1/2 inches or 2 inches, round.
 - b. Natural Gas: 1-1/2 inches or 2 inches, round.
 - c. Low-Pressure Compressed Air: 1-1/2 inches to 2 inches, round.
 - d. High-Pressure Compressed Air: 1-1/2 inches to 2 inches, round.
 - 2. Valve-Tag Colors:
 - a. Domestic Water: Natural.
 - b. Natural Gas: Natural.
 - c. Low-Pressure Compressed Air: Natural.
 - d. High-Pressure Compressed Air: Natural.
 - 3. Letter Colors:
 - a. Domestic Water: Black.
 - b. Natural Gas: Black.
 - c. Low-Pressure Compressed Air: Black.
 - d. High-Pressure Compressed Air: Black.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 22 05 53

**SECTION 22 07 19
PLUMBING PIPING INSULATION**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic hot-water piping.
 - 2. Domestic recirculating hot-water piping.
 - 3. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
- B. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
- D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
 - 1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
 - 2. Jacket Materials for Pipe: 12 inches long by NPS 2.
 - 3. Sheet Jacket Materials: 12 inches square.
 - 4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction.

Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
1. Piping Mockups:
 - a. One 10-foot section of NPS 2 straight pipe.
 - b. One each of a 90-degree threaded, welded, and flanged elbow.
 - c. One each of a threaded, welded, and flanged tee fitting.
 - d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
 - e. Four support hangers including hanger shield and insert.
 - f. One threaded strainer and one flanged strainer with removable portion of insulation.
 - g. One threaded reducer and one welded reducer.
 - h. One pressure temperature tap.
 - i. One mechanical coupling.
 2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
 3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 4. Obtain Architect's approval of mockups before starting insulation application.
 5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 7. Demolish and remove mockups when directed.
- D. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Pittsburgh Corning Corporation.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 5. Preformed Pipe Insulation with Factory-Applied ASJ or ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
 - 6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.
- I. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.
 - d. Owens Corning.
 - 2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

- J. Phenolic:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Kingspan Tarec Industrial Insulation NV.
 - b. Resolco International BV.
 - 2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
 - 3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
 - 4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
 - 5. Factory-Applied Jacket: ASJ. Requirements are specified in "Factory-Applied Jackets" Article.
- K. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Armacell LLC.
 - b. Nomaco Insulation.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ramco Insulation, Inc.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ramco Insulation, Inc.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ramco Insulation, Inc.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
 - 1. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
 - 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 3. Foster Brand; H. B. Fuller Construction Products.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. K-Flex USA.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.

- c. Foster Brand; H. B. Fuller Construction Products.
- d. Mon-Eco Industries, Inc.
- D. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
- E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
- F. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Dow Corning Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. P.I.C. Plastics, Inc.
 - d. Speedline Corporation.

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.
 - 2. Mastics shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Knauf Insulation.
 - d. Vimasco Corporation.
 - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.

3. Service Temperature Range: 0 to 180 deg F.
 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
 3. Service Temperature Range: Minus 50 to plus 220 deg F.
 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 5. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Knauf Insulation.
 - d. Vimasco Corporation.
 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Solids Content: 60 percent by volume and 66 percent by weight.
 5. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Vimasco Corporation.
 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 4. Service Temperature Range: 0 to plus 180 deg F.
 5. Color: White.

2.6 SEALANTS

- A. Joint Sealants for Cellular-Glass and Phenolic Products:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Permanently flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 100 to plus 300 deg F.
 5. Color: White or gray.

6. Sealant shall have a VOC content of 420 g/L or less.
 7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. FSK and Metal Jacket Flashing Sealants:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: Aluminum.
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: White.

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
 - b. Vimasco Corporation.

2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. P.I.C. Plastics, Inc.
 - c. Proto Corporation.
 - d. Speedline Corporation.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White or Color-code jackets based on system. Color as selected by Architect when exposed within building.
 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- C. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Pittsburgh Corning Corporation.
 - b. Polyguard Products, Inc.

2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 - c. Knauf Insulation.
 - d. Venture Tape.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 - c. Knauf Insulation.
 - d. Venture Tape.
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.



- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Compac Corporation.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 - c. Venture Tape.
 - 2. Width: 2 inches.
 - 3. Thickness: 6 mils.
 - 4. Adhesion: 64 ounces force/inch in width.
 - 5. Elongation: 500 percent.
 - 6. Tensile Strength: 18 lbf/inch in width.

2.11 SECUREMENTS

- A. Bands:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. RPR Products, Inc.
 - 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.
 - 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- C. Wire: 0.080-inch nickel-copper alloy, 0.062-inch soft-annealed, stainless steel or 0.062-inch soft-annealed, galvanized steel.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. C & F Wire.

2.12 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Insul-Tect Products Co.
 - b. McGuire Manufacturing.
 - c. Plumberex Specialty Products, Inc.
 - d. Truebro.
 - 2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- B. Protective Shielding Piping Enclosures:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Truebro.
 - b. Zurn Industries, LLC.
 - 2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches to 4 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistant joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 - 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 - 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 - 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 - 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie

wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
 1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
 1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed sections of cellular-glass insulation to valve body.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF PHENOLIC INSULATION

- A. General Installation Requirements:
1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
 2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
- B. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- C. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
- D. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- E. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.

3.10 INSTALLATION OF POLYOLEFIN INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of polyolefin pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.11 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.12 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.
- E. All adhesive shall be as recommended by cellular glass manufacturer and with a VOC content of 80 g/L or less.
- F. Per ASHRAE 189.1, All adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

3.14 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.15 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Hot and Recirculated Hot Water (HW Return):
 - 1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - d. Phenolic: 1 inch thick.
 - e. Polyolefin: 1 inch thick.
 - 2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - d. Phenolic: 1 inch thick.
 - e. Polyolefin: 1 inch thick.
- B. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - c. Polyolefin: 1 inch thick.
- C. Condensate Drain Piping where installed within building:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- D. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. None.
 - 2. PVC, Color-Coded by System: 20 mils or 30 mils thick.
 - 3. Aluminum, Smooth or Corrugated: 0.020 inch, 0.032 inch or 0.040 inch thick.
 - 4. Painted Aluminum, Smooth or Corrugated: 0.020 inch or 0.032 inch thick.
 - 5. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish or Corrugated: 0.020 inch or 0.024 inch thick.
- D. Piping, Exposed:
 - 1. None.
 - 2. PVC, Color-Coded by System: 20 mils or 30 mils thick.



3. Aluminum, Smooth or Corrugated: 0.020 inch, 0.032 inch or 0.040 inch thick.
4. Painted Aluminum, Smooth or Corrugated: 0.020 inch or 0.032 inch thick.
5. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish or Corrugated: 0.020 inch or 0.024 inch thick.

3.17 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 22 07 79

SECTION 22 10 23
FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Manual gas shutoff valves.
 - 5. Motorized gas valves.
 - 6. Earthquake valves.
 - 7. Pressure regulators.
 - 8. Service meters.
 - 9. Dielectric fittings.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Corrugated, stainless-steel tubing with associated components.
 - 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 4. Pressure regulators. Indicate pressure ratings and capacities.
 - 5. Service meters. Indicate pressure ratings and capacities. Include bypass fittings and meter bars with supports.
 - 6. Dielectric fittings.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
 - 1. Shop Drawing Scale: 1/4 inch to 1/8 per foot.
 - 2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.
- C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of seismic restraints.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.



1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- C. Qualification Data: For qualified professional engineer.
- D. Welding certificates.
- E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For motorized gas valves, pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.9 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Architect, Construction Manager and Owner no fewer than two days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Architect's, Construction Manager's or Owner's written permission.

1.10 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 100 psig minimum unless otherwise indicated.



3. Minimum Operating Pressure of Service Meter: 5 psig.
- B. Natural-Gas System Pressure within Buildings: 0.5 psig or less but not more than 2 psig.
- C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2.2 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
 6. Mechanical Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) GE Oil & Gas.
 - 2) Smith-Blair, Inc.
 - b. Stainless-steel or Steel flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. Stainless-steel or Steel bolts, washers, and nuts.
 - e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Parker Hannifin Corporation.
 - b. TracPipe CounterStrike; OmegaFlex, Inc.
 - c. Tru-Flex Metal Hose Corp.
 - d. Ward Manufacturing LLC.
 2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
 3. Coating: PE with flame retardant.
 - a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1) Flame-Spread Index: 25 or less.
 - 2) Smoke-Developed Index: 50 or less.



4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
 5. Striker Plates: Steel, designed to protect tubing from penetrations.
 6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
 7. Operating-Pressure Rating: 5 psig.
- C. PE Pipe: ASTM D 2513, SDR 11.
1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
 - b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded or flanged or suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
 4. Transition Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or flanged or suitable for welded connection.
 - c. Bridging sleeve over mechanical coupling.
 - d. Factory-connected anode.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
 5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Lyall, R. W. & Company, Inc.
 - 2) Mueller Co.
 - 3) Perfection Corporation.
 - b. PE body with molded-in, stainless-steel support ring.
 - c. Buna-nitrile seals.
 - d. Acetal collets.
 - e. Electro-zinc-plated steel stiffener.
 6. Plastic Mechanical Couplings, NPS 2and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Lyall, R. W. & Company, Inc.
 - 2) Mueller Co.
 - 3) Perfection Corporation.
 - b. Fiber-reinforced plastic body.
 - c. PE body tube.
 - d. Buna-nitrile seals.

- e. Acetal collets.
- f. Stainless-steel bolts, nuts, and washers.
- 7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) GE Oil & Gas.
 - 2) Smith-Blair, Inc.
 - b. Stainless-steel or Steel flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. Stainless-steel or Steel bolts, washers, and nuts.
 - e. Factory-installed anode for steel-body couplings installed underground.

2.3 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
 - 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 - 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
 - 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
 - 4. Corrugated stainless-steel tubing with polymer coating.
 - 5. Operating-Pressure Rating: 0.5 psig.
 - 6. End Fittings: Zinc-coated steel.
 - 7. Threaded Ends: Comply with ASME B1.20.1.
 - 8. Maximum Length: 72 inches.
- B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
 - 1. Copper-alloy convenience outlet and matching plug connector.
 - 2. Nitrile seals.
 - 3. Hand operated with automatic shutoff when disconnected.
 - 4. For indoor or outdoor applications.
 - 5. Adjustable, retractable restraining cable.
- C. Y-Pattern Strainers:
 - 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 - 3. Strainer Screen: 40 or 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 - 4. CWP Rating: 125 psig.
- D. Basket Strainers:
 - 1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 - 3. Strainer Screen: 40 or 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 - 4. CWP Rating: 125 psig.
- E. T-Pattern Strainers:
 - 1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
 - 2. End Connections: Grooved ends.
 - 3. Strainer Screen: 40 or 60-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
 - 4. CWP Rating: 750 psig.
- F. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.



2.4 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.5 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 6. Service Mark: Valves 1-1/4 inch to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 125 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Apollo Flow Controls; Conbraco Industries, Inc.
 - c. BrassCraft Manufacturing Co.; a Masco company.
 - d. Lyall, R. W. & Company, Inc.
 - e. Perfection Corporation.
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Ball: Chrome-plated brass.
 - 4. Stem: Bronze; blowout proof.
 - 5. Seats: Reinforced TFE; blowout proof.
 - 6. Packing: Separate packnut with adjustable-stem packing threaded ends.
 - 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 8. CWP Rating: 600 psig.
 - 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Apollo Flow Controls; Conbraco Industries, Inc.



- c. BrassCraft Manufacturing Co.; a Masco company.
 - d. Lyall, R. W. & Company, Inc.
 - e. Perfection Corporation.
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Ball: Chrome-plated bronze.
 - 4. Stem: Bronze; blowout proof.
 - 5. Seats: Reinforced TFE; blowout proof.
 - 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 - 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 8. CWP Rating: 600 psig.
 - 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Apollo Flow Controls; Conbraco Industries, Inc.
 - c. BrassCraft Manufacturing Co.; a Masco company.
 - d. Lyall, R. W. & Company, Inc.
 - e. Perfection Corporation.
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Ball: Chrome-plated bronze.
 - 4. Stem: Bronze; blowout proof.
 - 5. Seats: Reinforced TFE.
 - 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 - 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 8. CWP Rating: 600 psig.
 - 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- G. Bronze Plug Valves: MSS SP-78.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Lee Brass Company.
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Plug: Bronze.
 - 4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Operator: Square head or lug type with tamperproof feature where indicated.
 - 6. Pressure Class: 125 psig.
 - 7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- H. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. A.Y. McDonald Mfg. Co.

- b. Mueller Co.
 - c. Xomox Corporation.
 2. Body: Cast iron, complying with ASTM A 126, Class B.
 3. Plug: Bronze or nickel-plated cast iron.
 4. Seat: Coated with thermoplastic.
 5. Stem Seal: Compatible with natural gas.
 6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. Operator: Square head or lug type with tamperproof feature where indicated.
 8. Pressure Class: 125 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- I. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Flowserve Corporation.
 - c. Milliken Valve Company.
 - d. Mueller Co.
 2. Body: Cast iron, complying with ASTM A 126, Class B.
 3. Plug: Bronze or nickel-plated cast iron.
 4. Seat: Coated with thermoplastic.
 5. Stem Seal: Compatible with natural gas.
 6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. Operator: Square head or lug type with tamperproof feature where indicated.
 8. Pressure Class: 125 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- J. PE Ball Valves: Comply with ASME B16.40.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Kerotest Manufacturing Corp.
 - b. Lyall, R. W. & Company, Inc.
 - c. Perfection Corporation.
 2. Body: PE.
 3. Ball: PE.
 4. Stem: Acetal.
 5. Seats and Seals: Nitrile.
 6. Ends: Plain or fusible to match piping.
 7. CWP Rating: 80 psig.
 8. Operating Temperature: Minus 20 to plus 140 deg F.
 9. Operator: Nut or flat head for key operation.
 10. Include plastic valve extension.
 11. Include tamperproof locking feature for valves where indicated on Drawings.
- K. Valve Boxes:
1. Cast-iron, two-section box.
 2. Top section with cover with "GAS" lettering.
 3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.

4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.6 MOTORIZED GAS VALVES

- A. Automatic Gas Valves: Comply with ANSI Z21.21.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Dungs, Karl, Inc.
 - b. Eaton.
 - c. Eclipse Innovative Thermal Technologies.
 - d. Honeywell Building Solutions; Honeywell International, Inc.
 - e. Johnson Controls.
 2. Body: Brass or aluminum.
 3. Seats and Disc: Nitrile rubber.
 4. Springs and Valve Trim: Stainless steel.
 5. Normally closed.
 6. Visual position indicator.
 7. Electrical or Mechanical operator for actuation by appliance automatic shutoff device.
- B. Electrically Operated Valves: Comply with UL 429.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Dungs, Karl, Inc.
 - b. Eclipse Innovative Thermal Technologies.
 - c. Goyen Valve Corp.
 - d. Magnatrol Valve Corporation.
 - e. Parker Hannifin Corporation.
 - f. WATTS.
 2. Pilot operated.
 3. Body: Brass or aluminum.
 4. Seats and Disc: Nitrile rubber.
 5. Springs and Valve Trim: Stainless steel.
 6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
 7. NEMA ICS 6, Type 4, coil enclosure.
 8. Normally closed.
 9. Visual position indicator.

2.7 EARTHQUAKE VALVES

- A. Earthquake Valves, Maximum Operating Pressure of 5 psig: Comply with ASCE 25.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Vanguard Valves, Inc.
 2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 3. Maximum Operating Pressure: 5 psig.
 4. Cast-aluminum body with nickel-plated chrome steel internal parts.
 5. Nitrile-rubber valve washer.
 6. Sight windows for visual indication of valve position.
 7. Threaded end connections complying with ASME B1.20.1.
 8. Wall mounting bracket with bubble level indicator.
- B. Earthquake Valves, Maximum Operating Pressure of 60 psig: Comply with ASCE 25.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:



- a. Pacific Seismic Products, Inc.
 2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 3. Maximum Operating Pressure: 60 psig.
 4. Cast-aluminum body with stainless-steel internal parts.
 5. Nitrile-rubber, reset-stem o-ring seal.
 6. Valve position, open or closed, indicator.
 7. Composition valve seat with clapper held by spring or magnet locking mechanism.
 8. Level indicator.
 9. End Connections: Threaded for valves NPS 2 and smaller; flanged for valves NPS 2-1/2 and larger.

2.8 PRESSURE REGULATORS

- A. General Requirements:
 1. Single stage and suitable for natural gas.
 2. Steel jacket and corrosion-resistant components.
 3. Elevation compensator.
 4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.
- B. Service Pressure Regulators: Comply with ANSI Z21.80.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Actaris.
 - b. American Meter Company.
 - c. Fisher Control Valves & Instruments; a brand of Emerson Process Management.
 - d. Invensys.
 2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 6. Orifice: Aluminum; interchangeable.
 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
 9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
 10. Overpressure Protection Device: Factory mounted on pressure regulator.
 11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
 12. Maximum Inlet Pressure: 100 psig.
- C. Line Pressure Regulators: Comply with ANSI Z21.80.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Actaris.
 - b. American Meter Company.
 - c. Fisher Control Valves & Instruments; a brand of Emerson Process Management.
 - d. Invensys.
 - e. Maxitrol Company.
 2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.



6. Orifice: Aluminum; interchangeable.
 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
 9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
 10. Overpressure Protection Device: Factory mounted on pressure regulator.
 11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
 12. Maximum Inlet Pressure: 10 psig.
- D. Appliance Pressure Regulators: Comply with ANSI Z21.18.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Canadian Meter Company Inc.
 - b. Eaton.
 - c. Harper Wyman Co.
 - d. Maxitrol Company.
 2. Body and Diaphragm Case: Die-cast aluminum.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber.
 6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
 8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
 9. Maximum Inlet Pressure: 5 psig.

2.9 SERVICE METERS

- A. Diaphragm-Type Service Meters: Comply with ANSI B109.1, ANSI B109.2.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Actaris.
 - b. American Meter Company.
 - c. Invensys.
 - d. Itron Gas.
 2. Case: Die-cast aluminum.
 3. Connections: Steel threads.
 4. Diaphragm: Synthetic fabric.
 5. Diaphragm Support Bearings: Self-lubricating.
 6. Compensation: Continuous temperature and pressure.
 7. Meter Index: Cubic feet.
 8. Meter Case and Index: Tamper resistant.
 9. Remote meter reader compatible.
 10. Maximum Inlet Pressure: 100 psig.
 11. Pressure Loss: Maximum 0.5-inch wg or 2.0-inch wg.
 12. Accuracy: Maximum plus or minus 1.0 percent.
- B. Rotary-Type Service Meters: Comply with ANSI B109.3.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Meter Company.
 - b. Invensys.



2. Case: Extruded aluminum.
3. Connection: Flange.
4. Impellers: Polished aluminum.
5. Rotor Bearings: Self-lubricating.
6. Compensation: Continuous temperature and pressure.
7. Meter Index: Cubic feet.
8. Tamper resistant.
9. Remote meter reader compatible.
10. Maximum Inlet Pressure: 100 psig.
11. Accuracy: Maximum plus or minus 2.0 percent.

C. Service-Meter Bars:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. American Meter Company.
 - c. Lyall, R. W. & Company, Inc.
 - d. Perfection Corporation.
2. Malleable- or cast-iron frame for supporting service meter.
3. Include offset swivel pipes, meter nuts with o-ring seal, and factory- or field-installed dielectric unions.
4. Omit meter offset swivel pipes if service-meter bar dimensions match service-meter connections.

D. Service-Meter Bypass Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Lyall, R. W. & Company, Inc.
 - b. Williamson, T. D., Inc.
2. Ferrous, tee, pipe fitting with capped side inlet for temporary natural-gas supply.
3. Integral ball-check bypass valve.

2.10 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Central Plastics Company.
 - c. Matco-Norca.
 - d. WATTS.
2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Matco-Norca.
 - d. WATTS.
2. Description:



- a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 125 psig minimum at 180 deg F.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

2.11 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 and the California Plumbing code (CPC) to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 and the California Plumbing code (CPC) requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the California Plumbing Code (CPC) for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 3. Replace pipe having damaged PE coating with new pipe.

- E. Copper Tubing with Protective Coating:
 - 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
- F. Install fittings for changes in direction and branch connections.
- G. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."

3.4 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the California Plumbing Code (CPC) for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing



- rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 5. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use natural-gas piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.5 SERVICE-METER ASSEMBLY INSTALLATION

- A. Install service-meter assemblies aboveground, on concrete bases.
- B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.
- C. Install strainer on inlet of service-pressure regulator and meter set.
- D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.
- E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.
- F. Install service meters downstream from pressure regulators.
- G. Install metal bollards to protect meter assemblies. Comply with requirements in Section 055000 "Metal Fabrications" for pipe bollards.

3.6 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

3.7 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.8 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hangers and supports specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 - 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.
- D. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
 - 3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.9 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.

- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 PAINTING

- A. Comply with requirements in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting" for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel semigloss or gloss.
 - d. Color: Gray or yellow. Coordinate final color with Owner or Architect.
- C. Paint exposed, interior metal piping inside Mechanical rooms, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except devices and components, with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive or Quick-drying alkyd metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex semigloss or gloss.
 - d. Color: Gray or yellow. Coordinate final color with Owner or Architect.
 - 2. Alkyd System: MPI INT 5.1E.
 - a. Prime Coat: Alkyd anticorrosive or Quick-drying alkyd metal primer.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd semigloss or gloss.
 - d. Color: Gray or yellow. Coordinate final color with Owner or Architect.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Use 3000-psi minimum, 28-day, compressive-strength concrete and reinforcement as specified in Section 03 30 00 "Cast-in-Place Concrete."



3.13 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to NFPA 54, California Plumbing Code (CPC) and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.14 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.15 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be the following:
 - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
- B. Aboveground natural-gas piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed joints. Install piping embedded in concrete with no joints in concrete.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.16 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Underground, below building, piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.17 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
 - 1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
 - 2. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with steel welding fittings and welded joints.
- C. Underground, below building, piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.

2. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.18 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 5 PSIG

- A. Aboveground Piping: Maximum operating pressure more than 5 psig.
- B. Aboveground, Branch Piping: Steel pipe with steel welding fittings and welded joints.
- C. Aboveground, distribution piping shall be the following:
 1. Steel pipe with steel welding fittings and welded joints.
- D. Underground, below building, piping shall be one of the following:
 1. Steel pipe with malleable-iron fittings and threaded joints.
 2. Steel pipe with wrought-steel fittings and welded joints.
- E. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- F. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.19 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground:
 1. PE valves.
 2. NPS 2 and Smaller: Bronze plug valves.
 3. NPS 2-1/2 and Larger: Cast-iron, lubricated or nonlubricated plug valves.

3.20 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
 1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim.
 3. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
 1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.
 3. Cast-iron, nonlubricated plug valve.
- C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
 1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim.
 3. Bronze plug valve.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
 1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.
 3. Cast-iron, nonlubricated or lubricated plug valve.
- E. Valves in branch piping for single appliance shall be one of the following:
 1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim.
 3. Bronze plug valve.

END OF SECTION 22 10 23



**SECTION 22 11 16
DOMESTIC WATER PIPING AND FITTINGS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Copper tube and fittings.
 - 2. Ductile-iron pipe and fittings.
 - 3. Piping joining materials.
 - 4. Encasement for piping.
 - 5. Transition fittings.
 - 6. Dielectric fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Architect, Construction Manager and/or Owner no fewer than two days in advance of proposed interruption of water service.
 - 2. Do not interrupt water service without Architect's, Construction Manager's and/or Owner's written permission.

PART 2 - PRODUCTS

2.1 THE FOLLOWING PRODUCTS ARE BOARD OF TRUSTEES APPROVED SOLE SOURCE ITEMS. NO SUBSTITUTIONS WILL BE ACCEPTED.

- A. Wet Barrell Fire Hydrant: "Clow" Model 2065 Brass. Finish shall be pre-finished Red.
- B. Resilient Wedge Gate Valves: "Clow" Model No. 2639, 2640. Provide stainless steel bolts, not zinc.
- C. Ball Valve Curb Stops: "Ford/McDonald" Product No. 47280, 47930, 48410, 48670, 49080; B11 (2-1/2" and below).
- D. Backflow Devices: "Zurn/Wilkins" 2" 975XL2/10" 375AST.
- E. Fire Service Backflow Device: "Zurn/Wilkins" 375ASTDA.

2.2 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on applicable piping.

2.3 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type K water tube, drawn temper.

- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.
- F. Copper, Brass, or Bronze Pressure-Seal-Joint Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Elkhart Products Corporation.
 - c. Mueller Industries, Inc.
 - d. NIBCO INC.
 - 2. Fittings: Cast-brass, cast-bronze or wrought-copper with EPDM O-ring seal in each end. Sizes NPS 2-1/2 and larger with stainless steel grip ring and EPDM O-ring seal.
 - 3. Minimum 200-psig working-pressure rating at 250 deg F.
- G. Appurtenances for Grooved-End Copper Tubing:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Anvil International.
 - b. Grinnell Mechanical Products.
 - c. Shurjoint Piping Products USA Inc.
 - d. Victaulic Company.
 - 2. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75/B 75M copper tube or ASTM B 584 bronze castings.
 - 3. Mechanical Couplings for Grooved-End Copper Tubing:
 - a. Copper-tube dimensions and design similar to AWWA C606.
 - b. Ferrous housing sections.
 - c. EPDM-rubber gaskets suitable for hot and cold water.
 - d. Bolts and nuts.
 - e. Minimum Pressure Rating: 300 psig.

2.4 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe:
 - 1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Standard-Pattern, Mechanical-Joint Fittings:
 - 1. AWWA C110/A21.10, ductile or gray iron.
 - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- C. Compact-Pattern, Mechanical-Joint Fittings:
 - 1. AWWA C153/A21.53, ductile iron.
 - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- D. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.



- E. Appurtenances for Grooved-End, Ductile-Iron Pipe:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Shurjoint Piping Products USA Inc.
 - b. Smith-Cooper International.
 - c. Victaulic Company.
 - 2. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions that match pipe.
 - 3. Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:
 - a. AWWA C606 for ductile-iron-pipe dimensions.
 - b. Ferrous housing sections.
 - c. EPDM-rubber gaskets suitable for hot and cold water.
 - d. Bolts and nuts.
 - e. Minimum Pressure Rating:
 - 1) NPS 14 to NPS 18: 250 psig.
 - 2) NPS 20 to NPS 46: 150 psig.

2.5 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.6 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.
- B. Form: Sheet or tube.
- C. Color: Black or natural.

2.7 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Dresser, Inc.
 - b. Jay R. Smith Mfg. Co.
 - c. JCM Industries, Inc.
 - d. Smith-Blair, Inc.
- D. Plastic-to-Metal Transition Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. Charlotte Pipe and Foundry Company.
- b. Harvel Plastics, Inc.
- c. Spears Manufacturing Company.
- d. Uponor.
2. Description:
 - a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - b. One end with threaded brass insert and one solvent-cement-socket or threaded end.
- E. Plastic-to-Metal Transition Unions:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Colonial Engineering, Inc.
 - b. NIBCO INC.
 - c. Spears Manufacturing Company.
 2. Description:
 - a. CPVC or PVC four-part union.
 - b. Brass or stainless-steel threaded end.
 - c. Solvent-cement-joint or threaded plastic end.
 - d. Rubber O-ring.
 - e. Union nut.

2.8 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Central Plastics Company.
 - c. Matco-Norca.
 - d. Wilkins.
 2. Standard: ASSE 1079.
 3. Pressure Rating: 125 psig minimum at 180 deg F.
 4. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Central Plastics Company.
 - b. Matco-Norca.
 - c. WATTS.
 - d. Wilkins.
 2. Standard: ASSE 1079.
 3. Factory-fabricated, bolted, companion-flange assembly.
 4. Pressure Rating: 125 psig minimum at 180 deg F.
 5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.

- c. Central Plastics Company.
- d. Pipeline Seal and Insulator, Inc.
- 2. Nonconducting materials for field assembly of companion flanges.
- 3. Pressure Rating: 150 psig.
- 4. Gasket: Neoprene or phenolic.
- 5. Bolt Sleeves: Phenolic or polyethylene.
- 6. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Elster Perfection Corporation.
 - b. Grinnell Mechanical Products.
 - c. Matco-Norca.
 - d. Precision Plumbing Products.
 - 2. Standard: IAPMO PS 66.
 - 3. Electroplated steel nipple complying with ASTM F 1545.
 - 4. Pressure Rating and Temperature: 300 psig at 225 deg F.
 - 5. End Connections: Male threaded or grooved.
 - 6. Lining: Inert and noncorrosive, propylene.

2.9 ISOLATION VALVES FOR RESTROOMS

- A. All restrooms shall have standalone isolation valves for hot and cold water in case the restroom needs to be taken offline for service.

2.10 PLUMBING RENOVATION PROJECTS

- A. Replace water piping and fixture and/or valves servicing the building four (4) feet prior to the P.O.C.
- B. Replace backflow make-up assembly and pressure regulator.
- C. Install gages before and after the regulator.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- F. Install shutoff valve immediately upstream of each dielectric fitting.

- G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 11 19 "Domestic Water Piping Specialties."
- H. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
- I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- L. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- N. Install piping to permit valve servicing.
- O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- P. Install piping free of sags and bends.
- Q. Install fittings for changes in direction and branch connections.
- R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- S. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- T. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 22 11 23 "Domestic Water Pumps."
- U. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- G. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- H. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- I. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- J. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- K. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings, nipples or unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits or nipples.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 6. NPS 6: 10 feet with 5/8-inch rod.
 - 7. NPS 8: 10 feet with 3/4-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 - 7. NPS 6: 12 feet with 3/4-inch rod.
 - 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 - 7. NPS 6: 12 feet with 3/4-inch rod.
 - 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- J. Install supports for vertical stainless-steel piping every 15 feet.
- K. Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.



4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 2. Piping Tests:
 - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.10 ADJUSTING

- A. Perform the following adjustments before operation:
 1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.



6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Clean non-potable domestic water piping as follows:
 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be the following:
 1. Hard copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
- E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:
 1. Hard copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
 2. Mechanical-joint, ductile-iron pipe; standard or compact-pattern, mechanical-joint fittings; and mechanical joints.
 3. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- F. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12, shall be one of the following:

1. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.
 2. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- G. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:
1. Hard copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
- H. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; cast or wrought-copper, solder-joint fittings; and brazed or soldered joints.
 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
- I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; cast or wrought-copper, solder-joint fittings; and brazed or soldered joints.
 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
 3. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
- J. Aboveground domestic water piping, NPS 5 to NPS 8, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; cast or wrought-copper, solder-joint fittings; and brazed or soldered joints.
 2. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
 3. Stainless-steel Schedule 10 or Schedule 40 pipe, grooved-joint fittings, and grooved joints.
- K. Aboveground, combined domestic water-service and fire-service-main piping, NPS 6 to NPS 12, shall be one of the following:
1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
 2. Stainless-steel Schedule 10 or Schedule 40 pipe, grooved-joint fittings, and grooved joints.

3.13 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 3. Hot-Water Circulation Piping, Balancing Duty: Calibrated or Memory-stop balancing valves.
 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 22 11 16

**SECTION 22 11 19
DOMESTIC WATER PIPING SPECIALTIES**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Balancing valves.
 - 5. Temperature-actuated, water mixing valves.
 - 6. Strainers.
 - 7. Outlet boxes.
 - 8. Hose bibbs.
 - 9. Drain valves.
 - 10. Water-hammer arresters.
 - 11. Trap-seal primer valves.
 - 12. Trap-seal primer systems.
 - 13. Flexible connectors.
 - 14. Water meters.
- B. Related Requirements:
 - 1. Section 22 05 19 "Meters and Gauges for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
 - 2. Section 22 11 16 "Domestic Water Piping" for water meters.
 - 3. Section 22 47 13 "Drinking Fountains" for water filters for water coolers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
 - 1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 and NSF 14. Mark "NSF-pw" on applicable plastic piping components.
- B. Comply with NSF 372 for low lead.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. FEBCO; A WATTS Brand.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 - 2. Standard: ASSE 1001.
 - 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: Threaded.
 - 6. Finish: Rough bronze or Chrome plated.
- B. Hose-Connection Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Cash Acme, A Division of Reliance Worldwide Corporation.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 - 2. Standard: ASSE 1011.
 - 3. Body: Bronze, nonremovable, with manual drain.
 - 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 - 5. Finish: Chrome or nickel plated.
- C. Pressure Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. FEBCO; A WATTS Brand.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 - 2. Standard: ASSE 1020.
 - 3. Operation: Continuous-pressure applications.
 - 4. Pressure Loss: 5 psig maximum, through middle third of flow range.
 - 5. Size: Refer to Plumbing design drawings.
 - 6. Design Flow Rate: Refer to Plumbing design drawings.
 - 7. Selected Unit Flow Range Limits: Refer to Plumbing design drawings.
 - 8. Pressure Loss at Design Flow Rate: Refer to Plumbing design drawings.
 - 9. Accessories: Refer to Plumbing design drawings.
 - a. Valves: Ball type, on inlet and outlet.
- D. Laboratory-Faucet Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Woodford Manufacturing Company.
 - d. Zurn Industries, LLC.
 - 2. Standard: ASSE 1035.
 - 3. Size: NPS 1/4 or NPS 3/8 matching faucet size.



4. Body: Bronze.
 5. End Connections: Threaded.
 6. Finish: Chrome plated.
- E. Spill-Resistant Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 2. Standard: ASSE 1056.
 3. Operation: Continuous-pressure applications.
 4. Size: NPS 1/4, NPS 3/8, NPS 1/2, NPS 3/4 or NPS 1.
 5. Accessories: Refer to Plumbing design drawings.
 - a. Valves: Ball type, on inlet and outlet.

2.4 BACKFLOW PREVENTERS

- A. Intermediate Atmospheric-Vent Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. FEBCO; A WATTS Brand.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 2. Standard: ASSE 1012.
 3. Operation: Continuous-pressure applications.
 4. Size: NPS 1/2 or NPS 3/4.
 5. Body: Bronze.
 6. End Connections: Union, solder joint.
 7. Finish: Chrome plated or Rough bronze.
- B. Reduced-Pressure-Principle Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. FEBCO; A WATTS Brand.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 2. Standard: ASSE 1013.
 3. Operation: Continuous-pressure applications.
 4. Pressure Loss: 12 psig maximum, through middle third of flow range.
 5. Size: Refer to Plumbing design drawings.
 6. Design Flow Rate: Refer to Plumbing design drawings.
 7. Selected Unit Flow Range Limits: Refer to Plumbing design drawings.
 8. Pressure Loss at Design Flow Rate: Refer to Plumbing design drawings.
 9. Body: Bronze for NPS 2 and smaller; cast iron or steel with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
 10. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 11. Configuration: Designed for horizontal, straight-through or vertical-inlet, horizontal-center-section, and vertical-outlet flow.
 12. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.

- b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
- c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
- C. Double-Check, Backflow-Prevention Assemblies:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. FEBCO; A WATTS Brand.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 - 2. Standard: ASSE 1015.
 - 3. Operation: Continuous-pressure applications unless otherwise indicated.
 - 4. Pressure Loss: 5 psig maximum, through middle third of flow range.
 - 5. Size: Refer to Plumbing design drawings.
 - 6. Design Flow Rate: Refer to Plumbing design drawings.
 - 7. Selected Unit Flow Range Limits: Refer to Plumbing design drawings.
 - 8. Pressure Loss at Design Flow Rate: Refer to Plumbing design drawings.
 - 9. Body: Bronze for NPS 2 and smaller; cast iron or steel with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
 - 10. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 - 11. Configuration: Designed for horizontal, straight-through flow.
 - 12. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
- D. Beverage-Dispensing-Equipment Backflow Preventers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASSE 1022.
 - 3. Operation: Continuous-pressure applications.
 - 4. Size: NPS 1/4 or NPS 3/8.
 - 5. Body: Stainless steel.
 - 6. End Connections: Threaded.
- E. Dual-Check-Valve Backflow Preventers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. FEBCO; A WATTS Brand.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 - 2. Standard: ASSE 1024.
 - 3. Operation: Continuous-pressure applications.
 - 4. Size: NPS 1/2, NPS 3/4, NPS 1 or NPS 1-1/4.
 - 5. Body: Bronze with union inlet.
- F. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:



1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Cash Acme, A Division of Reliance Worldwide Corporation.
 - b. Lancer Corporation.
 - c. WATTS.
 2. Standard: ASSE 1032.
 3. Operation: Continuous-pressure applications.
 4. Size: NPS 1/4 or NPS 3/8.
 5. Body: Stainless steel.
 6. End Connections: Threaded.
- G. Reduced-Pressure-Detector, Fire-Protection, Backflow-Preventer Assemblies:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. FEBCO; A WATTS Brand.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 2. Standard: ASSE 1047 and is FM Global approved or UL listed.
 3. Operation: Continuous-pressure applications.
 4. Pressure Loss: 12 psig maximum, through middle third of flow range.
 5. Size: Refer to Plumbing/Fire Protection design drawings.
 6. Design Flow Rate: Refer to Plumbing/Fire Protection design drawings.
 7. Selected Unit Flow Range Limits: Refer to Plumbing/Fire Protection design drawings.
 8. Pressure Loss at Design Flow Rate: Refer to Plumbing/Fire Protection design drawings.
 9. Body: Cast iron or Steel with interior lining that complies with AWWA C550 or that is FDA approved or Stainless steel.
 10. End Connections: Flanged.
 11. Configuration: Designed for horizontal, straight-through or vertical-inlet, horizontal-center-section, and vertical-outlet flow.
 12. Accessories: Refer to Plumbing/Fire Protection design drawings.
 - a. Valves: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
 - c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
- H. Double-Check, Detector-Assembly Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. FEBCO; A WATTS Brand.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 2. Standard: ASSE 1048 and is FM Global approved or UL listed.
 3. Operation: Continuous-pressure applications.
 4. Pressure Loss: 5 psig maximum, through middle third of flow range.
 5. Size: Refer to Plumbing design drawings.
 6. Design Flow Rate: Refer to Plumbing design drawings.
 7. Selected Unit Flow Range Limits: Refer to Plumbing design drawings.
 8. Pressure Loss at Design Flow Rate: Refer to Plumbing design drawings.
 9. Body: Cast iron or Steel with interior lining that complies with AWWA C550 or that is FDA approved or Stainless steel.



10. End Connections: Flanged.
11. Configuration: Designed for horizontal, straight-through or vertical-inlet, horizontal-center-section, and vertical-outlet flow.
12. Accessories:
 - a. Valves: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
- I. Hose-Connection Backflow Preventers:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Woodford Manufacturing Company.
 2. Standard: ASSE 1052.
 3. Operation: Up to 10-foot head of water back pressure.
 4. Inlet Size: NPS 1/2 or NPS 3/4.
 5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
 6. Capacity: At least 3-gpm flow.
- J. Backflow-Preventer Test Kits:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. FEBCO; A WATTS Brand.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.5 WATER PRESSURE-REDUCING VALVES

- A. Water Regulators:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Cash Acme, A Division of Reliance Worldwide Corporation.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 2. Standard: ASSE 1003.
 3. Pressure Rating: Initial working pressure of 150 psig.
 4. Size: Refer to Plumbing design drawings.
 5. Design Flow Rate: Refer to Plumbing design drawings.
 6. Design Inlet Pressure: Refer to Plumbing design drawings.
 7. Design Outlet Pressure Setting: Refer to Plumbing design drawings.
 8. Body: Bronze with chrome-plated finish for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
 9. Valves for Booster Heater Water Supply: Include integral bypass.
 10. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.
- B. Water-Control Valves:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.

- b. CLA-VAL Automatic Control Valves.
- c. WATTS.
- d. Zurn Industries, LLC.
2. Description: Pilot-operated, diaphragm-type, single-seated, main water-control valve.
3. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
4. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
 - a. Size: Refer to Plumbing design drawings.
 - b. Pattern: Angle or Globe-valve design.
 - c. Trim: Stainless steel.
5. Design Flow: Refer to Plumbing design drawings.
6. Design Inlet Pressure: Refer to Plumbing design drawings.
7. Design Outlet Pressure Setting: Refer to Plumbing design drawings.
8. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

2.6 BALANCING VALVES

- A. Copper-Alloy Calibrated Balancing Valves:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Armstrong International, Inc.
 - b. ITT Corporation.
 - c. NIBCO INC.
 - d. TACO Comfort Solutions, Inc.
 2. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
 3. Body: Brass or bronze.
 4. Size: Same as connected piping, but not larger than NPS 2.
 5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
- B. Cast-Iron Calibrated Balancing Valves:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Armstrong International, Inc.
 - b. ITT Corporation.
 - c. NIBCO INC.
 - d. WATTS.
 2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
 3. Size: Same as connected piping, but not smaller than NPS 2-1/2.
- C. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
- D. Memory-Stop Balancing Valves:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Red White Valve Corp.
 2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
 3. Pressure Rating: 400-psig minimum CWP.
 4. Size: NPS 2 or smaller.
 5. Body: Copper alloy.

6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.7 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Leonard Valve Company.
 - c. POWERS; A WATTS Brand.
 - d. Symmons Industries, Inc.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded or union inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: Refer to Plumbing design drawings.
9. Tempered-Water Design Flow Rate: Refer to Plumbing design drawings.
10. Valve Finish: Chrome plated or Rough bronze.

B. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Lawler Manufacturing Company, Inc.
 - b. Leonard Valve Company.
 - c. POWERS; A WATTS Brand.
 - d. Symmons Industries, Inc.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed-mounted or Cabinet-type, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: Refer to Plumbing design drawings.
9. Tempered-Water Design Flow Rate: Refer to Plumbing design drawings.
10. Selected Valve Flow Rate at 45-psig Pressure Drop: Refer to Plumbing design drawings.
11. Pressure Drop at Design Flow Rate: Refer to Plumbing design drawings.
12. Valve Finish: Polished, chrome plated or Rough bronze.
13. Piping Finish: Chrome plated or Copper.
14. Cabinet: Factory fabricated, stainless steel, for recessed or surface mounting and with hinged, stainless-steel door.

C. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.



- b. Lawler Manufacturing Company, Inc.
- c. Leonard Valve Company.
- d. POWERS; A WATTS Brand.
2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: Refer to Plumbing design drawings.
9. Tempered-Water Design Flow Rate: Refer to Plumbing design drawings.
- D. Primary Water Tempering Valves:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Heat-Timer Corporation.
 - b. Holby Valve Inc.
 - c. Uponor.
 2. Standard: ASSE 1017, thermostatically controlled, water tempering valve, listed as tempering valve.
 3. Pressure Rating: 125 psig minimum unless otherwise indicated.
 4. Body: Bronze.
 5. Temperature Control: Manual.
 6. Inlets and Outlet: Threaded.
 7. Selected Primary Water Tempering Valve Size: Refer to Plumbing design drawings.
 8. Tempered-Water Setting: Refer to Plumbing design drawings.
 9. Tempered-Water Design Flow Rate: Refer to Plumbing design drawings.
 10. Pressure Drop at Design Flow Rate: Refer to Plumbing design drawings.
 11. Tempered-Water Outlet Size: Refer to Plumbing design drawings.
 12. Cold-Water Inlet Size: Refer to Plumbing design drawings.
 13. Hot-Water Inlet Size: Refer to Plumbing design drawings.
 14. Valve Finish: Rough bronze.

2.8 STRAINERS FOR DOMESTIC WATER PIPING

- A. Y-Pattern Strainers:
 1. Pressure Rating: 125 psig minimum unless otherwise indicated.
 2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
 3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 4. Screen: Stainless steel with round perforations unless otherwise indicated.
 5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020, 0.033, or 0.062 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045, 0.062 or 0.125 inch.
 - c. Strainers NPS 5 and Larger: 0.10, 0.125 or 0.25 inch.
 6. Drain: Pipe plug and Factory-installed, hose-end drain valve.

2.9 OUTLET BOXES

- A. Clothes Washer Outlet Boxes:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Guy Gray Manufacturing Co., Inc.
 - b. IPS Corporation.
 - c. LSP Products Group, Inc.

- d. Oatey.
 2. Mounting: Recessed.
 3. Material and Finish: Enameled-steel, epoxy-painted-steel or Stainless-steel box and faceplate.
 4. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
 5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
 6. Drain: NPS 1-1/2 or NPS 2 standpipe and P-trap for direct waste connection to drainage piping.
 7. Inlet Hoses: Two 60-inch-long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
 8. Drain Hose: One 48-inch-long, rubber household clothes washer drain hose with hooked end.
- B. Icemaker Outlet Boxes:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. IPS Corporation.
 - b. LSP Products Group, Inc.
 - c. Oatey.
 - d. Plastic Oddities.
 2. Mounting: Recessed.
 3. Material and Finish: Enameled-steel, epoxy-painted-steel or Stainless-steel box and faceplate.
 4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
 5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.10 HOSE BIBBS

- A. Hose Bibbs:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Acorn Manufacturing.
 - b. Jay R. Smith Mfg. Co.
 - c. Woodford Manufacturing Company.
 - d. Zurn Industries, LLC.
 2. Standard: ASME A112.18.1 for sediment faucets.
 3. Body Material: Bronze.
 4. Seat: Bronze, replaceable.
 5. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
 6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
 7. Pressure Rating: 125 psig.
 8. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
 9. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
 10. Finish for Service Areas: Rough bronze, Chrome or nickel plated.
 11. Finish for Finished Rooms: Chrome or nickel plated.
 12. Operation for Equipment Rooms: Wheel handle or operating key.
 13. Operation for Service Areas: Wheel handle or Operating key.
 14. Operation for Finished Rooms: Operating key.
 15. Include operating key with each operating-key hose bibb.
 16. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.11 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-110 for standard-port, two-piece ball valves.

2. Pressure Rating: 400-psig minimum CWP.
 3. Size: NPS 3/4.
 4. Body: Copper alloy.
 5. Ball: Chrome-plated brass.
 6. Seats and Seals: Replaceable.
 7. Handle: Vinyl-covered steel.
 8. Inlet: Threaded or solder joint.
 9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.
- B. Gate-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-80 for gate valves.
 2. Pressure Rating: Class 125.
 3. Size: NPS 3/4.
 4. Body: ASTM B 62 bronze.
 5. Inlet: NPS 3/4 threaded or solder joint.
 6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.
- C. Stop-and-Waste Drain Valves:
1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
 2. Pressure Rating: 200-psig minimum CWP or Class 125.
 3. Size: NPS 3/4.
 4. Body: Copper alloy or ASTM B 62 bronze.
 5. Drain: NPS 1/8 side outlet with cap.

2.12 WATER-HAMMER ARRESTERS

- A. Water-Hammer Arresters:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. MIFAB, Inc.
 - b. Precision Plumbing Products.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. WATTS.
 2. Standard: ASSE 1010 or PDI-WH 201.
 3. Type: Metal bellows or Copper tube with piston.
 4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.13 TRAP-SEAL PRIMER DEVICE

- A. Supply-Type, Trap-Seal Primer Device:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. Precision Plumbing Products.
 - d. WATTS.
 2. Standard: ASSE 1018.
 3. Pressure Rating: 125 psig minimum.
 4. Body: Bronze.
 5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
 6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
 7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.
- B. Drainage-Type, Trap-Seal Primer Device:



1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
3. Size: NPS 1-1/4 minimum.
4. Material: Chrome-plated, cast brass.

2.14 TRAP-SEAL PRIMER SYSTEMS

- A. Trap-Seal Primer Systems:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Precision Plumbing Products.
 - b. Zurn Industries, LLC.
 2. Standard: ASSE 1044.
 3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
 4. Cabinet: Recessed or Surface-mounted steel box with stainless-steel cover.
 5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 6. Vacuum Breaker: ASSE 1001.
 7. Number Outlets: Refer to Plumbing design drawings.
 8. Size Outlets: NPS 1/2 or NPS 5/8.

2.15 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Flex-Hose Co., Inc.
 2. Flexicraft Industries.
 3. Flex-Weld, Inc.
 4. Metraflex Company (The).
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
1. Working-Pressure Rating: Minimum 200 psig to 250 psig.
 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
1. Working-Pressure Rating: Minimum 200 psig to 250 psig.
 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.16 WATER METERS

- A. Displacement-Type Water Meters:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. AALIANT.
 - b. ABB.
 - c. Mueller Co.
 - d. Sensus.
 2. Standard: AWWA C700.
 3. Pressure Rating: 150-psig working pressure.



4. Body Design: Nutating disc; totalization meter.
 5. Registration: In gallons or cubic feet as required by utility company.
 6. Case: Bronze.
 7. End Connections: Threaded.
- B. Turbine-Type Water Meters:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Badger Industries, Inc.
 - b. Hays Fluid Controls.
 - c. Master Meter, Inc.
 - d. Sensus.
 2. Standard: AWWA C701.
 3. Pressure Rating: 150 psig working pressure.
 4. Body Design: Turbine; totalization meter.
 5. Registration: In gallons or cubic feet as required by utility company.
 6. Case: Bronze.
 7. End Connections for Meters NPS 2 and Smaller: Threaded.
 8. End Connections for Meters NPS 2-1/2 and Larger: Flanged.
- C. Compound-Type Water Meters:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Badger Industries, Inc.
 - b. Master Meter, Inc.
 - c. Mueller Co.
 - d. Sensus.
 2. Standard: AWWA C702.
 3. Pressure Rating: 150-psig working pressure.
 4. Body Design: With integral mainline and bypass meters; totalization meter.
 5. Registration: In gallons or cubic feet as required by utility company.
 6. Case: Bronze.
 7. Pipe Connections: Flanged.
- D. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Backflow Preventers: Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- B. Water Regulators: Install with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

- C. Water Control Valves: Install with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.
- D. Balancing Valves: Install in locations where they can easily be adjusted.
- E. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 - 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Y-Pattern Strainers: For water, install on supply side of each control valve, water pressure-reducing valve, solenoid valve and/or pump.
- G. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
- H. Water-Hammer Arresters: Install in water piping according to PDI-WH 201.
- I. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- J. Drainage-Type, Trap-Seal Primer Device: Install as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
- K. Trap-Seal Primer Systems: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.
- L. Hose Bibb: Provide hose bibbs in all student restrooms, in boiler rooms, on rooftops with skylights or air-cooling equipment.

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.
- C. Comply with requirements for grounding equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

3.3 IDENTIFICATION

- A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Intermediate atmospheric-vent backflow preventers.
 - 3. Reduced-pressure-principle backflow preventers.
 - 4. Double-check, backflow-prevention assemblies.
 - 5. Carbonated-beverage-machine backflow preventers.
 - 6. Dual-check-valve backflow preventers.
 - 7. Reduced-pressure-detector, fire-protection, backflow-preventer assemblies.
 - 8. Double-check, detector-assembly backflow preventers.
 - 9. Water pressure-reducing valves.
 - 10. Calibrated balancing valves.
 - 11. Primary, thermostatic, water mixing valves.
 - 12. Manifold, thermostatic, water mixing-valve assemblies.
 - 13. Photographic-process, thermostatic, water mixing-valve assemblies.
 - 14. Primary water tempering valves.
 - 15. Outlet boxes.
 - 16. Supply-type, trap-seal primer valves.
 - 17. Trap-seal primer systems.



- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer, double-check, backflow-prevention assembly and/or double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 22 11 19

SECTION 22 11 23
DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Multiplex, variable-speed booster pumps.
- B. Related Requirements:
 - 1. Section 22 11 23 "Domestic Water Pumps" for domestic-water circulation pumps.

1.3 DEFINITIONS

- A. PID: Proportional Integral Derivative.
- B. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, and dimensions of individual components and profiles.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For booster pumps.
 - 1. Include plans, elevations, sections, mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Delegated-Design Submittal: For domestic-water packaged booster pumps.
 - 1. Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for booster pumps, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For booster pumps to include in emergency, operation, and maintenance manuals.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Retain protective coatings and flange's protective covers during storage.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.
- B. Seismic Performance: Booster pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the booster pump will remain in place without separation of any parts from the booster pump when subjected to the seismic forces specified and the booster pump will be fully operational after the seismic event."

2.2 MULTIPLEX, VARIABLE-SPEED BOOSTER PUMPS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Armstrong Pumps, Inc.
 - 2. Grundfos Pumps Corporation U.S.A.
 - 3. Quantumflo, Inc.
 - 4. SyncroFlo, Inc.
- B. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.
- C. Pumps:
 - 1. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
 - 2. Casing: Radially split; **[bronze]** **[cast iron]** **[stainless steel]**.
 - 3. Impeller: Closed, **[ASTM B 584 cast bronze]** **[stainless steel]** **<Insert material>**; statically and dynamically balanced and keyed to shaft.
 - 4. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
 - 5. Seal: Mechanical.
 - 6. Orientation: Mounted **[horizontally]** **[or]** **[vertically]**.
- D. Pumps:
 - 1. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, frame-mounted, separately coupled, single-stage, overhung-impeller, centrifugal pump. **[Include back-pullout design.]**
 - 2. Casing: Radially split; **[bronze]** **[cast iron]** **[stainless steel]**.
 - 3. Impeller: Closed, **[ASTM B 584 cast bronze]** **[stainless steel]** **<Insert material>**; statically and dynamically balanced and keyed to shaft.
 - 4. Shaft and Shaft Sleeve: Stainless-steel **[or steel]** shaft, with copper-alloy shaft sleeve and deflector.
 - 5. Seal: Mechanical.
 - 6. Bearing: **[Grease-lubricated]** **[or]** **[pre-greased, permanently shielded]** ball type.
 - 7. Coupling: Flexible, with metal guard.
- E. Pumps:
 - 1. Type: In line, single stage as defined in HI 1.1-1.2 and HI 1.3 for in-line, single-stage, close-coupled, overhung-impeller, centrifugal pump.
 - 2. Casing: Radially split; **[bronze]** **[cast iron]** **[stainless steel]**.
 - 3. Impeller: Closed, **[ASTM B 584 cast bronze]** **[stainless steel]** **<Insert material>**; statically and dynamically balanced and keyed to shaft.
 - 4. Shaft and Shaft Sleeve: Stainless-steel **[or steel]** shaft, with copper-alloy shaft sleeve.
 - 5. Seal: Mechanical.
 - 6. Bearing: **[Grease-lubricated]** **[or]** **[pre-greased, permanently shielded]** ball type.

- F. Pumps:
1. Type: Vertical, multistage as defined in HI 1.1-1.2 and HI 1.3 for in-line, multistage, separately coupled, overhung-impeller, centrifugal pump.
 2. Casing: Cast-iron or steel base and stainless-steel chamber.
 3. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
 4. Shaft: Stainless steel.
 5. Seal: Mechanical.
 6. Bearing: Water-lubricated sleeve type.
- G. Pumps:
1. Type: Vertical, can, as defined in HI 2.1-2.2 and HI 2.3 for in-line, barrel or can, lineshaft, vertical pump.
 2. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
 3. Bowls: **[Epoxy-coated cast iron] [Cast iron] <Insert material>**.
 4. Shaft: Stainless steel.
 5. Seals: Mechanical and stuffing-box types.
 6. Bearings: Water-lubricated bushing type.
- H. Motors: Single speed, with grease-lubricated or pre-greased, permanently shielded, ball-bearings. Select motors that will not overload through full range of pump performance curve.
- I. Piping: Copper tube and copper fittings, Stainless-steel pipe and fittings, Stainless-steel pipe and fitting headers and copper tube and copper fittings between headers and pump or Galvanized-steel pipe and cast-iron fittings.
- J. Valves:
1. Shutoff Valves NPS 2 and Smaller: Gate valve or two-piece, full-port ball valve, in each pump's suction and discharge piping.
 2. Shutoff Valves NPS 2-1/2 and Larger: Gate valve or lug-type butterfly valve, in each pump's suction and discharge piping and in inlet and outlet headers.
 3. Check Valves NPS 2 and Smaller: Silent or swing type in each pump's discharge piping.
 4. Check Valves NPS 2-1/2 and Larger: Silent type in each pump's discharge piping.
 5. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.
- K. Dielectric Fittings: With insulating material to isolate joined dissimilar metals.
- L. VFC: Comply with Section 262923 "Variable-Frequency Motor Controllers."
- M. VFC: Serving each pump in pump array.
1. Manufactured Units: Pulse-width modulated; **[constant torque] [and] [variable torque] <Insert application>** for **[Design A and Design B] [inverter-duty]** motors.
 2. Output Rating: Three phase; 10 to **[60 Hz, with voltage proportional to frequency throughout voltage range] [66 Hz, with torque constant as speed changes]**; maximum voltage equals input voltage.
 3. Unit Operating Requirements:
 - a. Internal Adjustability:
 - 1) Minimum Speed: 5 to 25 percent of maximum rpm.
 - 2) Maximum Speed: 80 to 100 percent of maximum rpm.
 - 3) Acceleration: 0.1 to 999.9 seconds.
 - 4) Deceleration: 0.1 to 999.9 seconds.
 - 5) Current Limit: 30 to minimum of 150 percent of maximum rating.
 - b. Self-Protection and Reliability Features:
 - 1) Surge suppression.
 - 2) Loss of input signal protection.
 - 3) Under- and overvoltage trips.
 - 4) VFC and motor overload/overtemperature protection.

- 5) Critical frequency rejection.
- 6) Loss-of-phase protection.
- 7) Reverse-phase protection.
- 8) Motor-overtemperature fault.
- c. Bidirectional autospeed search.
- d. Torque boost.
- e. Motor temperature compensation at slow speeds.
 - 1) Panel-mounted operator station.
 - 2) Historical logging information and displays.
 - 3) Digital indicating devices.
- f. Control Signal Interface: Electric.
- g. Proportional Integral Derivative (PID) control interface.
- h. DDC System for HVAC Protocols for Network Communications: ASHRAE 135.
- 4. Line Conditioning:
 - a. Input line conditioning.
 - b. Output filtering.
 - c. EMI/RFI filtering.
- 5. Bypass Systems:
 - a. Bypass Mode: Manual operation only or Field-selectable automatic or manual.
 - b. Bypass Controller: Two-contactor style, with bypass and output isolating contactors and isolating switch.
 - c. Bypass Controller: Three-contactor style, with bypass and input and output isolating contactors and isolating switch.
 - d. Bypass Contactor Configuration: Full-voltage (across the line) or Reduced-voltage (autotransformer) type.
- 6. Instrumentation: Suction and discharge pressure gauges.
- 7. Lights: Running light for each pump.
- 8. Alarm Signal Device: Sounds alarm when backup pumps are operating.
 - a. Time Delay: Controls alarm operation; adjustable from 1 to 300 seconds, with automatic or manual reset.
- 9. Thermal-bleed cutoff.
- 10. Low-suction-pressure or Water-storage-tank, low-level cutout.
- 11. High-suction-pressure cutout.
- 12. Low-discharge-pressure cutout.
- 13. High-discharge-pressure cutout.
- 14. Direct Digital Control (DDC) System for HVAC: Provide auxiliary contacts for interface to BACnet or comparable DDC system. Verify protocol with Owner prior to purchase to ensure proper operation and integration with pump. DDC systems are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Include the following:
 - a. On-off status of each pump.
 - b. Alarm status.
- N. Base: Structural steel.
- O. Capacities and Characteristics:
 - 1. Minimum Pressure Rating: 150 or 250 psig.
 - 2. Booster-Pump Capacity: Refer to Plumbing design drawings.
 - 3. Minimum Inlet Pressure: Refer to Plumbing design drawings.
 - 4. Maximum Inlet Pressure: Refer to Plumbing design drawings.
 - 5. Discharge Pressure: Refer to Plumbing design drawings.
 - 6. Low-Suction-Pressure Shutoff: Refer to Plumbing design drawings.
 - 7. High-Suction-Pressure Shutoff: Refer to Plumbing design drawings.



8. Low-Discharge-Pressure Shutoff: Refer to Plumbing design drawings.
9. High-Discharge-Pressure Shutoff: Refer to Plumbing design drawings.
10. Header Size: Refer to Plumbing design drawings.
11. Lead Pump:
 - a. Capacity: <Insert number> gpm.
 - b. Total Dynamic Head: <Insert number> feet.
 - c. Speed: <Insert number> rpm.
 - d. Electrical Characteristics:
 - 1) Motor Horsepower: <Insert number>.
 - 2) Volts: [120] [240] [277] [480] <Insert number> V.
 - 3) Phases: [Single] [Three].
 - 4) Hertz: 60 <Insert number> Hz.
12. Each of [Two] <Insert number> Lag Pumps:
 - a. Capacity: <Insert number> gpm.
 - b. Total Dynamic Head: <Insert number> feet.
 - c. Speed: <Insert number> rpm.
 - d. Electrical Characteristics:
 - 1) Motor Horsepower: <Insert number>.
 - 2) Volts: [120] [240] [277] [480] <Insert number> V.
 - 3) Phases: [Single] [Three].
 - 4) Hertz: 60 <Insert number> Hz.
13. Booster-Pump Electrical Characteristics:
 - a. Full-Load Amperes: <Insert number> A.
 - b. Minimum Circuit Ampacity: <Insert number> A.
 - c. Maximum Overcurrent Protection: <Insert number> A.

2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.
 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in NFPA 70.

2.4 SOURCE QUALITY CONTROL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. ASME Compliance: Comply with ASME B31.9 for piping.
- C. UL Compliance for Packaged Pumping Systems:
 1. UL 508, "Industrial Control Equipment."
 2. UL 508A, "Industrial Control Panels."
 3. UL 778, "Motor-Operated Water Pumps."
 4. UL 1995, "Heating and Cooling Equipment."
- D. Booster pumps shall be listed and labeled as packaged pumping systems by testing agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

3.2 INSTALLATION

- A. Booster-Pump Mounting:
 - 1. Install booster pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete." Or Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 - 3. Comply with requirements for vibration isolation devices specified in Section 22 05 48 "Vibration Controls for Plumbing Piping and Equipment."
- B. Support connected domestic-water piping so weight of piping is not supported by booster pumps.

3.3 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Booster-Pump Piping Connections: Connect domestic-water piping to booster pumps. Install suction and discharge pipe equal to or greater than size of system suction and discharge headers or piping.
 - 1. Install shutoff valves on piping connections to booster-pump suction and discharge headers or piping. Install ball, butterfly, or gate valves same size as suction and discharge headers or piping. Comply with requirements for general-duty valves specified in Section 22 05 23 "General Duty Valves for Plumbing Piping."
 - 2. Install union, flanged, or grooved-joint connections on suction and discharge headers or piping at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Section 22 11 16 "Domestic Water Piping."
 - 3. Install valved bypass, same size as and between piping, at connections to booster-pump suction and discharge headers or piping. Comply with requirements for domestic-water piping specified in Section 22 11 16 "Domestic Water Piping."
 - 4. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge headers or piping. Comply with requirements for flexible connectors specified in Section 22 11 16 "Domestic Water Piping."
 - 5. Where installing piping adjacent to booster pumps, allow space for service and maintenance.

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."
- B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
 - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.



3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Perform visual and mechanical inspection.
 - 2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Pumps and controls will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

3.8 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.9 ADJUSTING

- A. Adjust booster pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust pressure set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain booster pumps.

END OF SECTION 22 11 23

**SECTION 22 13 16
SANITARY WASTE AND VENT PIPING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Ductile-iron pipe and fittings.
 - 2. Copper tube and fittings.
 - 3. ABS pipe and fittings.
 - 4. PVC pipe and fittings.
 - 5. Specialty pipe fittings.
 - 6. Encasement for underground metal piping.
- B. Related Requirements:
 - 1. Section 22 13 29 "Sanitary Sewerage Pumps" for effluent and sewage pumps.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Architect, Construction Manager and Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
 - 2. Do not proceed with interruption of sanitary waste service without Architect's, Construction Manager's and Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Waste, Force-Main Piping: 50 psig, 100 psig or 150 psig.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.



2.2 PIPING MATERIALS

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 DUCTILE-IRON PIPE AND FITTINGS

- A. Ductile-Iron, Mechanical-Joint Piping:
 - 1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
 - 2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
 - 3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Ductile-Iron, Grooved-Joint Piping: AWWA C151/A21.51, with round-cut-grooved ends according to AWWA C606.
- C. Ductile-Iron, Grooved-End Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Anvil International.
 - b. Shurjoint Piping Products USA Inc.
 - c. Smith-Cooper International.
 - d. Victaulic Company.
 - 2. Grooved-End, Ductile-Iron Fittings: ASTM A 536 ductile-iron castings, with dimensions matching AWWA C110/A 21.10 ductile-iron pipe or AWWA C153/A 21.53 ductile-iron fittings, and complying with AWWA C606 for grooved ends.
 - 3. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.4 COPPER TUBE AND FITTINGS

- A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.
- D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.
- E. Copper Pressure Fittings:
 - 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.5 ABS PIPE AND FITTINGS

- A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
- C. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.
- D. Solvent Cement: ASTM D 2235.
 - 1. Solvent cement shall have a VOC content of 325 g/L or less.
 - 2. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.6 PVC PIPE AND FITTINGS

- A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F 656.
 - 1. Adhesive primer shall have a VOC content of 550 g/L or less.
 - 2. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- E. Solvent Cement: ASTM D 2564.
 - 1. Solvent cement shall have a VOC content of 510 g/L or less.

2.7 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - 2. Unshielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Mission Rubber Company, LLC; a division of MCP Industries.
 - 4) Plastic Oddities.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.
 - e. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 - 3. Shielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:



- 1) Cascade Waterworks Mfg. Co.
- 2) Mission Rubber Company, LLC; a division of MCP Industries.
- b. Standard: ASTM C 1460.
- c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- d. End Connections: Same size as and compatible with pipes to be joined.
4. Pressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) EBAA Iron, Inc.
 - 3) Jay R. Smith Mfg. Co.
 - 4) JCM Industries, Inc.
 - b. Standard: AWWA C219.
 - c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
 - d. Center-Sleeve Material: Manufacturer's standard, Carbon steel, Stainless steel, Ductile iron or Malleable iron.
 - e. Gasket Material: Natural or synthetic rubber.
 - f. Metal Component Finish: Corrosion-resistant coating or material.
- B. Dielectric Fittings:
 1. Dielectric Unions:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) A.Y. McDonald Mfg. Co.
 - 2) HART Industrial Unions, LLC.
 - 3) Matco-Norca.
 - 4) Zurn Industries, LLC.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 125 psig minimum at 180 deg F.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
 2. Dielectric Flanges:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Capitol Manufacturing Company.
 - 2) Central Plastics Company.
 - 3) Matco-Norca.
 - 4) Zurn Industries, LLC.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 125 psig minimum at 180 deg F.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
 3. Dielectric-Flange Insulating Kits:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Advance Products & Systems, Inc.
 - 2) Calpico, Inc.

- 3) Central Plastics Company.
- 4) Pipeline Seal and Insulator, Inc.
- b. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig.
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel backing washers.
4. Dielectric Nipples:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Elster Perfection Corporation.
 - 2) Grinnell Mechanical Products.
 - 3) Matco-Norca.
 - 4) Precision Plumbing Products.
 - b. Description:
 - 1) Standard: IAPMO PS 66.
 - 2) Electroplated steel nipple.
 - 3) Pressure Rating: 300 psig at 225 deg F.
 - 4) End Connections: Male threaded or grooved.
 - 5) Lining: Inert and noncorrosive, propylene.

2.8 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Standard: ASTM A 674 or AWWA C105/A 21.5.
- B. Material: Linear low-density polyethylene film of 0.008-inch or high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.
- C. Form: Sheet or tube.
- D. Color: Black or natural.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.



- I. Install piping to allow application of insulation.
- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
 - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
 - 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 - 3. Do not change direction of flow more than 90 degrees.
 - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste piping in direction of flow is prohibited.
- L. Lay buried building waste piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
- M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 or 2 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- O. Install steel piping according to applicable plumbing code.
- P. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.
- Q. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- R. Install engineered soil and waste and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 - 2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
 - 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- S. Install underground, ductile-iron, force-main piping according to AWWA C600.
 - 1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
 - 2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 - 3. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- T. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
 - 1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- U. Install force mains at elevations indicated.
- V. Plumbing Specialties:
 - 1. Install backwater valves in sanitary waster gravity-flow piping.
 - a. Comply with requirements for backwater valves specified in Section 22 13 19 "Sanitary Waste Piping Specialties."



2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
3. Install drains in sanitary waste gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
- W. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- X. Install sleeves for piping penetrations of walls, ceilings, and floors.
 1. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- Y. Install sleeve seals for piping penetrations of concrete walls and slabs.
 1. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- Z. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 1. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- AA. Condensate Drain Trap: provide take-down unions on inlet and outlet sides of Condensate drain traps.

3.3 JOINT CONSTRUCTION

- A. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
 1. Cut threads full and clean using sharp dies.
 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - c. Do not use pipe sections that have cracked or open welds.
- B. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.
- C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- D. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- E. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 1. Install transition couplings at joints of piping with small differences in ODs.
 2. In Waste Drainage Piping: Unshielded or Shielded, nonpressure transition couplings.
 3. In Aboveground Force Main Piping: Fitting-type transition couplings.
 4. In Underground Force Main Piping:
 - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
 - b. NPS 2 and Larger: Pressure transition couplings.
- B. Dielectric Fittings:
 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits or nipples.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

- A. Comply with requirements in Section 22 05 23 "General Duty Valves for Plumbing Piping" for valve installation requirements.
- B. Shutoff Valves:
 1. Install shutoff valve on each sewage pump discharge.
 2. Install gate or full-port ball valve for piping NPS 2 and smaller.
 3. Install gate valve for piping NPS 2-1/2 and larger.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
 2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
 3. Install backwater valves in accessible locations.
 4. Comply with requirements for backwater valve specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment." and Section 22 05 48 "Vibration Controls for Plumbing Piping and Equipment."
 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting, valve and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install supports for vertical steel piping every 15 feet.
- G. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 2: 84 inches with 3/8-inch rod.
 2. NPS 3: 96 inches with 1/2-inch rod.
 3. NPS 4: 108 inches with 1/2-inch rod.
 4. NPS 6: 10 feet with 5/8-inch rod.

- H. Install supports for vertical stainless-steel piping every 10 feet.
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
 - 5. NPS 6: 10 feet with 5/8-inch rod.
 - 6. NPS 8: 10 feet with 3/4-inch rod.
- J. Install supports for vertical copper tubing every 10 feet.
- K. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
 - 1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 - 5. Install horizontal backwater valves with cleanout cover flush with floor or in pit with pit cover flush with floor.
 - 6. Comply with requirements for backwater valves, cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 7. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Connect force-main piping to the following:
 - 1. Sanitary Sewer: To exterior force main.
 - 2. Sewage Pump: To sewage pump discharge.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
 - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow to stand for four hours.
 - b. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
 - 1. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
 - 2. Copper Type DWV tube, copper drainage fittings, and soldered joints.
 - 3. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 - 4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 5. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.
- C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
 - 1. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
 - 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 3. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.
- D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
 - 1. Stainless-steel pipe and fittings gaskets, and gasketed joints.
 - 2. Copper Type DWV tube, copper drainage fittings, and soldered joints.
 - a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
 - 3. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 - 4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 5. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.
- E. Aboveground, vent piping NPS 5 and larger shall be any of the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.
- F. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
 - 1. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
 - 2. Solid wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 - 3. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 4. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.
- G. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
 - 1. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.
- H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be any of the following:
 - 1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 - 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
- I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 shall be any of the following:
 - 1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 - 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
 - 3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
- J. Underground sanitary-sewage force mains NPS 4 and smaller shall be any of the following:



1. Hard copper tube, Type L; wrought-copper pressure fittings; and soldered joints.
 2. Ductile-iron, mechanical-joint piping and mechanical joints.
 3. Ductile-iron, grooved-joint piping and grooved joints.
 4. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.
- K. Underground sanitary-sewage force mains NPS 5 and larger shall be any of the following:
1. Hard copper tube, Type L; wrought-copper pressure fittings; and soldered joints.
 2. Ductile-iron, mechanical-joint piping and mechanical joints.
 3. Ductile-iron, grooved-joint piping and grooved joints.
 4. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION 22 13 16

**SECTION 22 13 19
SANITARY WASTE PIPING SPECIALTIES**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Backwater valves.
 - 2. Cleanouts.
 - 3. Roof flashing assemblies.
 - 4. Through-penetration firestop assemblies.
 - 5. Miscellaneous sanitary drainage piping specialties.
 - 6. FOG disposal systems.
 - 7. Floor drains.
 - 8. Floor sinks.
 - 9. Trench drains.
 - 10. Channel drainage systems.
- B. Related Requirements:
 - 1. Section 22 14 23 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene.
- E. PE: Polyethylene.
- F. PP: Polypropylene.
- G. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Data: For each type of product. Include rated capacities, operating characteristics, and accessories for the following:
 - 1. FOG disposal systems.
- C. Shop Drawings:
 - 1. Show fabrication and installation details for frost-resistant vent terminals.
 - 2. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: For FOG disposal systems, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.



3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cultures: Provide 1-gal. bottles of bacteria culture recommended by manufacturer of FOG disposal systems equal to 200 percent of amount installed, but no fewer than (2) 1-gal. bottles.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.
- D. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

2.2 BACKWATER VALVES

- A. Horizontal, Cast-Iron Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. WATTS.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: Hub and spigot or hubless.
7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed or open for airflow unless subject to backflow condition as required.
8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

- B. Drain-Outlet Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. WATTS.
 - d. Zurn Industries, LLC.
2. Size: Same as floor drain outlet.
3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.

6. Outlet: Threaded or spigot.

2.3 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. WATTS.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Stainless-Steel Exposed Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. BLÜCHER; A Watts brand.
 - b. Josam Company.
 - c. WATTS.
2. Standard: ASME A112.3.1.
3. Size: Same as connected drainage piping
4. Body Material: Stainless-steel tee with side cleanout as required to match connected piping.
5. Closure: Stainless-steel plug with seal.

C. Cast-Iron Exposed Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. WATTS.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing or threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Heavy-duty, adjustable housing or Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: As Required.
7. Outlet Connection: Inside calk, Spigot or Threaded.
8. Closure: Brass plug with straight threads and gasket or Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads or setscrews.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy, Polished bronze or Rough bronze.
11. Frame and Cover Shape: Round. Square when specifically requested by owner.
12. Top Loading Classification: Heavy duty at exterior locations. Light or Medium Duty within building.
13. Riser: ASTM A 74, Extra-Heavy or Service class, cast-iron drainage pipe fitting and riser to cleanout.

D. Stainless-Steel Exposed Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. BLÜCHER; A Watts brand.



- b. Josam Company.
 - c. Kusel Equipment Co.
 - d. WATTS.
2. Standard: ASME A112.3.1.
 3. Size: Same as connected branch.
 4. Housing: Stainless steel.
 5. Closure: Stainless steel with seal.
 6. Riser: ASTM A 74, Extra-Heavy or Service class, stainless-steel drainage pipe fitting and riser to cleanout.
 7. Body or Ferrule: Stainless steel.
 8. Clamping Device: As Required.
 9. Outlet Connection: Inside calk, Spigot or Threaded.
 10. Closure: Brass plug with straight threads and gasket or Brass plug with tapered threads.
 11. Adjustable Housing Material: Cast iron with threads or setscrews.
 12. Frame and Cover Material and Finish: Nickel-bronze, copper alloy or Stainless steel.
 13. Frame and Cover Shape: Round. Square when specifically requested by owner.
 14. Top Loading Classification: Heavy duty at exterior locations. Light or Medium Duty within building.
- E. Cast-Iron Wall Cleanouts:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 2. Standard: ASME A112.36.2M. Include wall access.
 3. Size: Same as connected drainage piping.
 4. Body: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
 5. Closure Plug:
 - a. Brass or Cast iron.
 - b. Countersunk or raised head.
 - c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as or not more than one size smaller than cleanout size.
 6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
 7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.4 ROOF FLASHING ASSEMBLIES

- A. Roof Flashing Assemblies:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Acorn Engineering Company.
 - b. Thaler Metal Industries Ltd.
 - c. Zurn Industries, LLC.
 2. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch or 6.0-lb/sq. ft., 0.0938-inch-thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - a. Open-Top Vent Cap: Without cap.
 - b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 - c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

- A. Through-Penetration Firestop Assemblies:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ProSet Systems Inc.
 - 2. Standard: UL 1479 assembly of sleeve-and-stack fitting with firestopping plug.
 - 3. Size: Same as connected soil, waste, or vent stack.
 - 4. Sleeve: Molded-PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
 - 5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
 - 6. Special Coating: Corrosion resistant on interior of fittings.

2.6 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Open Drains:
 - 1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564 rubber gaskets.
 - 2. Size: Same as connected waste piping with increaser fitting of size indicated.
- B. Deep-Seal Traps:
 - 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 - 2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch-minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.
- C. Floor-Drain, Trap-Seal Primer Fittings:
 - 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 - 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.
- D. Air-Gap Fittings:
 - 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 - 2. Body: Bronze or cast iron.
 - 3. Inlet: Opening in top of body.
 - 4. Outlet: Larger than inlet.
 - 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- E. Sleeve Flashing Device:
 - 1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch to 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
 - 2. Size: As required for close fit to riser or stack piping.
- F. Stack Flashing Fittings:
 - 1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
 - 2. Size: Same as connected stack vent or vent stack.
- G. Vent Caps:



1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Expansion Joints:

1. Standard: ASME A112.6.4.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.7 FOG DISPOSAL SYSTEMS

A. FOG Disposal Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
2. Standard: ASME A112.14.6, for removing solids from and breaking down and digesting suspended fats, oils, and greases from food-preparation or processing wastewater.
3. Flow-Control Fitting: Matching unit size.
4. Strainer Unit: Stainless-steel housing with aluminum cover and removable-basket-type, stainless-steel, wire-mesh strainer. Include pressure plug instead of cover, Include extra basket and Include stainless-steel extension as required.
5. Media Chamber: Stainless-steel housing and aluminum cover, with internal baffles, piping, plastic coalescing surfaces, and clarifier section with test ports. Include stainless-steel extension as required.
6. Shelf: Stainless steel, 19-1/2 inches wide by 13 inches high by 8-3/4 inches deep, for metering pump, control devices, and culture bottle.
7. Culture Metering Pump, Timer, Control, and Tubing: Proprietary.
8. Culture: Include 1-gal. bottle, as recommended by unit manufacturer.
9. Strainer and Media Chamber, Unit Size: **20 gpm or 35 gpm.**
10. Inlet and Outlet: NPS 2.
11. Strainer and Media-Chamber, Unit Size: **50 gpm or 75 gpm.**
12. Inlet and Outlet: NPS 3.
13. Piping: Waste and vent piping is specified in Section 221316 "Sanitary Waste and Vent Piping."
14. Power Requirement: [**120-V ac**] <Insert power>.
15. Full-Load Amperes: <Insert number> A.
16. Minimum Circuit Ampacity: <Insert number> A.
17. Maximum Overcurrent Protection: <Insert number> A.

2.8 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. Wade; a subsidiary of McWane Inc.
 - d. WATTS.
2. Standard: ASME A112.6.3 with backwater valve where required.
3. Pattern: Area or Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: As Required.
6. Anchor Flange: As Required.
7. Clamping Device: As Required.

8. Outlet: Bottom.
 9. Backwater Valve: Drain-outlet type or Integral, ASME A112.14.1, swing-check type.
 10. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
 11. Sediment Bucket: As Required.
 12. Top or Strainer Material: Nickel bronze or Stainless steel.
 13. Top of Body and Strainer Finish: Nickel bronze or Stainless steel.
 14. Top Shape: Round. Square when specifically requested by owner.
 15. Dimensions of Top or Strainer: Refer to Plumbing Fixture Schedule on Construction Plans for body, sump, and grate requirements.
 16. Top Loading Classification: Heavy duty at exterior locations. Light or Medium Duty within building.
 17. Funnel: Not required.
 18. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 19. Trap Material: Bronze, Cast iron or Copper.
 20. Trap Pattern: Deep-seal P-trap or Standard P-trap.
 21. Trap Features: Trap-seal primer valve drain connection.
- B. Stainless-Steel Floor Drains, ASME A112.3.1:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Zurn Industries, LLC.
 2. Outlet: Bottom or Side.
 3. Top or Strainer Material: Stainless steel.
 4. Top Shape: Round. Square when specifically requested by owner.
 5. Dimensions of Top or Strainer: Refer to Plumbing Fixture Schedule on Construction Plans for body, sump, and grate requirements.
 6. Seepage Flange: As Required.
 7. Anchor Flange: As Required.
 8. Clamping Device: As Required.
 9. Trap-Primer Connection: Required.
 10. Trap Material: Stainless steel.
 11. Trap Pattern: Deep-seal P-trap or Standard P-trap.

2.9 FLOOR SINKS

- A. Cast-Iron Floor Sinks:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. Wade; a subsidiary of McWane Inc.
 - d. Watts; a Watts Water Technologies company.
 2. Standard: ASME A112.6.7.
 3. Pattern: Floor drain.
 4. Body Material: Cast iron.
 5. Anchor Flange: As Required, with seepage holes.
 6. Clamping Device: As Required.
 7. Outlet: Bottom, no-hub connection.
 8. Coating on Interior Surfaces: Acid-resistant enamel.
 9. Sediment Bucket: Not required.
 10. Internal Strainer: Dome or Flat.
 11. Internal Strainer Material: Aluminum.

12. Top Grate Material: Cast iron, loose.
13. Top of Body and Grate Finish: Nickel bronze, Acid-resistant enamel.
14. Top Shape: Square.
15. Dimensions of Top Grate: Refer to Plumbing Fixture Schedule on Construction plans.
16. Top Loading Classification: No traffic.
17. Funnel: Not required.

2.10 TRENCH DRAINS

- A. Trench Drains:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. Wade; a subsidiary of McWane Inc.
 - d. WATTS.
 2. Standard: ASME A112.6.3 for trench drains.
 3. Material: Ductile or gray iron.
 4. Flange: Anchor or Seepage, or As Required.
 5. Clamping Device: As Required.
 6. Outlet: Bottom, End or Side.
 7. Grate Material: Ductile iron or Stainless steel.
 8. Grate Finish: Painted or coated as required.
 9. Dimensions of Frame and Grate: Refer to Plumbing Fixture Schedule on Construction plans for dimensions, body, sump, and grate requirements.
 10. Top Loading Classification: Heavy duty at exterior locations. Light or Medium Duty within building.
 11. Trap Material: Cast iron or Stainless steel.
 12. Trap Pattern: Standard P-trap.

2.11 CHANNEL DRAINAGE SYSTEMS

- A. Stainless-Steel Channel Drainage Systems, ASME A112.3.1:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Josam Company.
 2. Description: Modular system of stainless-steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 3. Standard: ASME A112.3.1 for trench drains.
 4. Channel Sections: Interlocking joint, stainless steel with level invert.
 - a. Dimensions: 4 or 6 inches wide. Include number of units required to form total lengths indicated. Refer to Plumbing Fixture Schedule on Construction Plans.
 5. Grates: Manufacturer's designation "heavy or medium duty," with slots or perforations, and of width and thickness that fit recesses in channels.
 - a. Material: Stainless steel.
 - b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 6. Covers: Stainless steel, of width and thickness that fit recesses in channels, and of lengths indicated.
 7. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
 8. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- B. Stainless-Steel Channel Drainage Systems, Non-ASME A112.3.1:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. MultiDrain Systems, Inc.
 - b. Zurn Industries, LLC.



2. Description: Modular system of stainless-steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 3. Channel Sections: Interlocking joint, stainless steel with level invert.
 - a. Dimensions: 4 or 6 inches wide. Include number of units required to form total lengths indicated.
 4. Grates: Manufacturer's designation "heavy or medium duty," with slots or perforations, and of width and thickness that fit recesses in channels.
 - a. Material: Galvanized steel or Stainless steel.
 - b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 5. Covers: Stainless steel, of width and thickness that fit recesses in channels, and of lengths indicated.
 6. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
 7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- C. Narrow, Sloped-Invert, Polymer-Concrete Channel Drainage Systems:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ACO USA.
 - b. Jay R. Smith Mfg. Co.
 - c. MIFAB, Inc.
 - d. Polycast: Hubbell Power Systems, Inc.
 2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 3. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.
 - a. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
 - b. Include extension sections necessary for required depth.
 - c. Dimensions: 4-inch inside width. Include number of units required to form total lengths indicated.
 - d. Frame: Gray-iron or galvanized steel for grates.
 4. Grates: Manufacturer's designation "heavy or medium duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
 - a. Material: Stainless steel.
 - 1) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 5. Covers: Stainless Steel, of width and thickness that fit recesses in channel sections, and of lengths indicated.
 6. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
 7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- D. Narrow, Level-Invert, Polymer-Concrete Channel Drainage Systems:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ABT, Inc.
 - b. ACO USA.
 - c. Josam Company.
 - d. MIFAB, Inc.
 2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 3. Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps.



- a. Include rounded bottom, with level invert and with NPS 4 outlets in number and locations indicated.
 - b. Dimensions: 5-inch inside width and 9-3/4 inches deep. Include number of units required to form total lengths indicated.
 - 1) Frame: Gray-iron or galvanized steel for grates.
 4. Grates: Manufacturer's designation "heavy or medium duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
 - a. Material: Ductile iron, Fiberglass, Galvanized steel or Stainless steel.
 - b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 5. Covers: Stainless Steel, of width and thickness that fit recesses in channel sections, and of lengths indicated.
 6. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
 7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- E. FRP Channel Drainage Systems:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ACO USA.
 - b. Aquaduct, Inc.
 - c. Jay R. Smith Mfg. Co.
 - d. Zurn Industries, LLC.
 2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 3. Channel Sections: Interlocking-joint, sloped-invert, FRP modular units, with end caps. Include flat, rounded, or inclined inside bottom, with outlets in number, sizes, and locations indicated.
 - a. Dimensions: 4 or 6 inches wide. Include number of units required to form total lengths indicated. Refer to Plumbing Fixture Schedule on Construction Drawings.
 - b. Frame: Galvanized steel, Stainless steel or Manufacturer's standard metal for grates.
 4. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.
 - a. Material: Fiberglass or Stainless steel.
 - b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 5. Covers: Stainless Steel, of width and thickness that fit recesses in channel sections, and of lengths indicated.
 6. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
 7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.12 MOTORS

- A. General requirements for motors are specified in Section 22 05 13 "Common Motor Requirements for Plumbing Equipment."
 1. Motor Sizes: Minimum size as indicated. If not indicated, motor shall be large enough, so driven load will not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment Mounting:
 1. Install FOG disposal systems on cast-in-place concrete equipment base(s).
 - a. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete." And/or Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."
 2. Comply with requirements for vibration-isolation and seismic-control devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 3. Comply with requirements for vibration-isolation devices specified in Section 22 05 48.13 "Vibration Controls for Plumbing Piping and Equipment."

- B. Install backwater valves in building drain piping.
1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
 5. At each horizontal drainage pipe upper terminal.
 6. Above each Urinal
 7. Above each Water Closet
 8. Above each Sink
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 07 62 00 "Sheet Metal Flashing and Trim."
- G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 07 62 00 "Sheet Metal Flashing and Trim."
- H. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
1. Comply with requirements in Section 07 84 13 "Penetration Firestopping."
- I. Assemble open drain fittings and install with top of hub 1 inch or 2 inches above floor.
- J. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- K. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 2. Size: Same as floor drain inlet.
- L. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- M. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- N. Install vent caps on each vent pipe passing through roof.
- O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- P. Assemble components of FOG disposal systems and install on floor.
1. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction.
 2. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated.
 3. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.
- Q. Install wood-blocking reinforcement for wall-mounting-type specialties.
- R. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- S. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.



2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
 3. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
 - a. Maintain integrity of waterproof membranes where penetrated.
 5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- T. Install trench drains at low points of surface areas to be drained.
 1. Set grates of drains flush with finished surface, unless otherwise indicated.
- U. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.
 1. Install on support devices, so that top will be flush with adjacent surface.
- V. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.
- W. Install plastic channel drainage system components on support devices, so that top will be flush with adjacent surface.
- X. Install open drain fittings with top of hub 1 inch² inches above floor.

3.2 CONNECTIONS

- A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. FOG Disposal Systems: Connect inlet and outlet to unit, connect flow-control fitting and fresh-air inlet piping to unit inlet piping, and connect vent piping between trap and media chamber. Connect electrical power.
- D. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- F. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- G. Comply with requirements in Section 22 13 19 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.
- H. Comply with requirements in Section 22 13 23 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.

3.3 FLASHING INSTALLATION

- A. Comply with requirements in Section 07 62 00 "Sheet Metal Flashing and Trim."
- B. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.
- C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.



- D. Set flashing on floors and roofs in solid coating of bituminous cement.
- E. Secure flashing into sleeve and specialty clamping ring or device.
- F. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 07 62 00 "Sheet Metal Flashing and Trim."
- G. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. FOG disposal systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
 - 1. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections, and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled FOG disposal systems and their installation, including piping and electrical connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain FOG disposal systems. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 22 13 19



**SECTION 22 13 23
SANITARY WASTE INTERCEPTORS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Grease interceptors.
 - 2. Grease removal devices.
 - 3. Oil interceptors.
 - 4. Sand interceptors.
 - 5. Solids interceptors.

1.3 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.
- B. PP: Polypropylene plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of metal and plastic interceptor. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.
- B. Shop Drawings: For each type and size of precast concrete interceptor indicated.
 - 1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Piping connections. Include size, location, and elevation of each.
 - 2. Interface with underground structures and utility services.

1.6 FIELD CONDITIONS

- A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services according to requirements indicated:
 - 1. Notify Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of sewer services without Architect's, Construction Manager's and Owner's written permission.

PART 2 - PRODUCTS

2.1 GREASE INTERCEPTORS

- A. Precast Concrete Grease Interceptors: Comply with ASTM C 913 and Authorities having jurisdiction requirements.
 - 1. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.
 - 2. Structural Design Loads:
 - a. Light-Traffic Load: Comply with ASTM C 890, A-8.
 - b. Medium-Traffic Load: Comply with ASTM C 890, A-12.
 - c. Heavy-Traffic Load: Comply with ASTM C 890, A-16.

- d. Walkway Load: Comply with ASTM C 890, A-03.
 3. Resilient Pipe Connectors: ASTM C 923, cast or fitted into interceptor walls, for each pipe connection.
 4. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of interceptor to finished grade is less than 60 inches.
 5. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
 6. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.
 - a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
 - b. Gray Iron: ASTM A 48/A 48M, Class 35, unless otherwise indicated.
 - c. Include indented top design with lettering cast into cover, using wording equivalent to "GREASE INTERCEPTOR or SANITARY SEWER" accordingly."
- B. Cast-Iron or Steel Grease Interceptors:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 2. Standard: ASME A112.14.3 and PDI-G101, for intercepting and retaining fats, oils, and greases from food-preparation or -processing wastewater.
 3. Plumbing and Drainage Institute Seal: As Required.
 4. Body Material: Cast iron or steel.
 5. Interior Lining: Corrosion-resistant enamel or lining.
 6. Exterior Coating: Corrosion-resistant enamel.
 7. Body Dimensions: Refer to Plumbing Fixture and Equipment Schedules on Construction Plans.
 8. Body Extension: As Required.
- C. Plastic Grease Interceptors:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. Canplas LLC.
 - c. Green Turtle Zurn.
 - d. Zurn Industries, LLC.
 2. Standard: ASME A112.14.3 and PDI-G101, for intercepting and retaining fats, oils, and greases from food-preparation or -processing wastewater.
 3. Plumbing and Drainage Institute Seal: As Required.
 4. Body Material: Plastic.
 5. Body Dimensions: Refer to Plumbing Fixture and Equipment Schedules on Construction Plans.
 6. Body Extension: As Required.
- D. Capacities and Characteristics:
1. Length by Width by Depth: Refer to Plumbing Fixture and Equipment Schedules on Construction Plans.
 2. Number of Compartments: **Two**.
 3. Flow Rate: **<Insert interceptor design rate>**.
 4. Retention Capacity: **<Insert gal. or lb>**.
 5. Inlet and Outlet Pipe Size: 4" NPS minimum.
 - a. Centerline of Inlet to Floor: **<Insert inches>**.

- b. Centerline of Outlet to Floor: <Insert inches>.
6. End Connections: [Flanged] [Hub] [Threaded].
7. Cleanout: Integral[or field installed on outlet].
8. Trapped Outlet Required: [Integral] [No] [Yes].
9. Vent Pipe Size: [Not required] <Insert NPS>.
10. Mounting: [Above floor] [Recessed in acid-resistant, coated steel frame and cradle] [Recessed, flush with floor] <Insert mounting>.
11. Flow-Control Fitting: [Not required] [Required].
12. Operation: [Automatic recovery] [Manual cleaning] [Semiautomatic, manual drawoff] <Insert operation>.

2.2 GREASE REMOVAL DEVICES

- A. Grease Removal Devices:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Goslyn Environmental Systems, Inc.
 - b. International Grease Recovery Device.
 - c. Josam Company.
 - d. Thermaco, Inc.
 2. Standard: ASME A112.14.4[and with PDI-G101 for flow tests], for automatic intercepting and removal of fats, oils, and greases from food[-preparation] [or] [-processing] <Insert application> wastewater.
 3. Body Material: [Stainless steel] [Steel] <Insert material>.
 4. Interior Separation Device: [Baffles] [Screens] <Insert device>.
 5. Heater: [Not required] [Required].
 6. Interior Lining: [Not required] <Insert description if required>.
 7. Exterior Coating: [Not required] <Insert description if required>.
 8. Unit Dimensions: <Insert dimensions>.
 9. Flow Rate: <Insert recovery unit design rate>.
 10. Basket Material: [Stainless steel] <Insert material>.
 11. Inlet and Outlet Size: <Insert size>.
 12. End Connections: [Flanged] [Hub] [Threaded].
 13. Cleanout: Integral[or field installed on outlet].
 14. Mounting: [Above floor] <Insert mounting>.
 15. Flow-Control Fitting: [Not required] [Required].
 16. Operation: [Automatic recovery] <Insert operation>.
 17. Power Requirement: [120-V ac] <Insert power>.
 18. Full-Load Amperes: <Insert value> A.
 19. Minimum Circuit Ampacity: <Insert value> A.
 20. Maximum Overcurrent Protection: <Insert value> A.
 21. Waste Grease Receptacle: [Furnished by Owner] <Insert description>.

2.3 OIL INTERCEPTORS

- A. Precast Concrete Oil Interceptors: Comply with [ASTM C 913] <Insert authorities having jurisdiction>.
 1. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.
 2. Structural Design Loads:
 - a. Light-Traffic Load: Comply with ASTM C 890, A-8.
 - b. Medium-Traffic Load: Comply with ASTM C 890, A-12.
 - c. Heavy-Traffic Load: Comply with ASTM C 890, A-16.
 - d. Walkway Load: Comply with ASTM C 890, A-03.

3. Resilient Pipe Connectors: ASTM C 923, cast or fitted into interceptor walls, for each pipe connection.
 4. Steps: [**Individual FRP steps or FRP ladder**] [**Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP**] [**ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP**] <Insert material>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of interceptor to finished grade is less than [**60 inches**] <Insert dimension>.
 5. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
 6. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.
 - a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
 - b. Gray Iron: ASTM A 48/A 48M, Class 35, unless otherwise indicated.
 - c. Include indented top design with lettering cast into cover, using wording equivalent to "[**INTERCEPTOR**] [**OIL INTERCEPTOR**] [**SANITARY SEWER**] <Insert lettering>."
 7. Waste-oil storage tank and piping are specified in Section 231113 "Facility Fuel-Oil Piping."
- B. Cast-Iron or Steel Oil Interceptors: Factory-fabricated; with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Applied Chemical Technology, Incorporated.
 - b. Jay R. Smith Mfg. Co.
 - c. Rockford Sanitary Systems, Inc.
 - d. Schier Products Company.
 2. Inlet, Outlet, Vent, and Waste-Oil Outlet Piping Connections: Hub, hubless, or threaded, unless otherwise indicated.
 3. Extension: Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.
 4. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C 890, [**A-03, walkway**] <Insert loading type> load.
 5. Comply with requirements in Section 23 11 13 "Facility Fuel-Oil Piping" for waste-oil storage tank and piping.
- C. Plastic Oil Interceptors: Removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ashland Trap Distribution Co.
 - b. Green Turtle Zurn.
 - c. Schier Products Company.
 - d. Town & Country Plastics, Inc.
 2. Inlet, Outlet, Vent, and Waste-Oil Outlet Piping Connections: Hub, hubless, or threaded, unless otherwise indicated.
 3. Extension: Plastic shroud, full size of interceptor, extending from top of interceptor to grade.
 4. Cover: Plastic[**with steel reinforcement to provide ASTM C 890,**] [**A-03, walkway**] <Insert loading type> load.
 5. Waste-oil storage tank and piping are specified in Section 23 11 13 "Facility Fuel-Oil Piping."
- D. Capacities and Characteristics:
1. Capacity: [**Not applicable**] <Insert gal. >.
 2. Overall Dimensions: <Insert inches>.

3. Flow Rate: **<Insert interceptor design rate>**.
4. Inlet and Outlet Pipe Size: **<Insert NPS>**.
 - a. Centerline of Inlet to Floor: **<Insert inches>**.
 - b. Centerline of Outlet to Floor: **<Insert inches>**.
5. End Connections: **[Flanged] [Hub] [Threaded]**.
6. Waste-Oil-Outlet Pipe Size: **<Insert NPS>**.
 - a. Centerline of Outlet to Floor: **<Insert inches>**.
7. Trapped Outlet Required: **[Integral] [No] [Yes]**.
8. Cleanout: Integral **[or field installed on outlet]**.
9. Vent Pipe Size: **<Insert NPS>**.
10. Mounting: **[Above floor] [Recessed in acid-resistant, coated steel frame and cradle] [Recessed, flush with floor] <Insert mounting>**.
11. Flow-Control Fitting: **[Not required] [Required]**.

2.4 SAND INTERCEPTORS

- A. Description: Factory-fabricated, cast-iron or steel body and inlet grate; with settlement chamber and removable basket or strainer.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Applied Chemical Technology, Incorporated.
 2. Josam Company.
 3. Rockford Sanitary Systems, Inc.
 4. Schier Products Company.
- C. Outlet Piping Connection: Hub, hubless, or threaded, unless otherwise indicated.
- D. Grate: Cast iron or steel with reinforcement to provide ASTM C 890, **[A-03, walkway] <Insert loading type>** load.
- E. Capacities and Characteristics:
 1. Capacity: **[Not applicable] <Insert gal. >**.
 2. Overall Dimensions: **<Insert inches>**.
 3. Outlet Pipe Size: **<Insert NPS>**.
 4. Trapped Outlet Required: **[Integral] [No] [Yes]**.
 5. Vent Pipe Size: **[Not required] <Insert NPS>**.
 6. Installation Position: **[Top flush with grade] <Insert position>**.

2.5 SOLIDS INTERCEPTORS

- A. Cast-Iron or Steel Solids Interceptors **<Insert drawing designation if any>**:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Josam Company.
 - b. Rockford Sanitary Systems, Inc.
 - c. Schier Products Company.
 - d. WATTS.
 2. Type: Factory-fabricated interceptor made for removing and retaining **[lint] [sediment] <Insert solid>** from wastewater.
 3. Body Material: Cast iron or steel.
 4. Interior Separation Device: **[Baffles] [Screens] <Insert device>**.
 5. Interior Lining: **[Corrosion-resistant enamel] [Not required] <Insert lining>**.
 6. Exterior Coating: **[Corrosion-resistant enamel] [Not required] <Insert coating>**.
 7. Body Dimensions: **<Insert dimensions>**.
 8. Flow Rate: **[Not required] <Insert description if required>**.
 9. Inlet and Outlet Size: **<Insert size>**.

10. End Connections: **[Threaded]** <Insert connections>.
 11. Mounting: **[Above floor]** **[Inline]** <Insert mounting>.
- B. Plastic Solids Interceptors:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ashland Trap Distribution Co.
 - b. Green Turtle Zurn.
 - c. Schier Products Company.
 - d. Town & Country Plastics, Inc.
 2. Type: Factory-fabricated interceptor made for removing and retaining **[lint]** **[sediment]** <Insert solid> from wastewater.
 3. Body Material: Plastic.
 4. Interior Separation Device: **[Baffles]** **[Screens]** <Insert device>.
 5. Body Dimensions: <Insert dimensions>.
 6. Flow Rate: **[Not required]** <Insert description if required>.
 7. Inlet and Outlet Size: <Insert size>.
 8. End Connections: **[Threaded]** <Insert connections>.
 9. Mounting: **[Above floor]** **[Inline]** <Insert mounting>.

2.6 PRECAST CONCRETE MANHOLE RISERS

- A. Precast Concrete Manhole Risers: ASTM C 478 and/or ASTM C 913, with rubber-gasket joints.
1. Structural Design Loads:
 - a. Light-Traffic Load: Comply with ASTM C 890, A-8.
 - b. Medium-Traffic Load: Comply with ASTM C 890, A-12.
 - c. Heavy-Traffic Load: Comply with ASTM C 890, A-16.
 - d. Walkway Load: Comply with ASTM C 890, A-03.
 2. Length: From top of underground concrete structure to grade.
 3. Riser Sections: 3-inch minimum thickness and 36-inch diameter.
 4. Top Section: Eccentric cone, unless otherwise indicated. Include top of cone to match grade ring size.
 5. Gaskets: ASTM C 443, rubber.
 6. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals.
- B. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, diameter matching manhole frame and cover, and height as required to adjust the manhole frame and cover to indicated elevation and slope.
- C. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.
1. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
 2. Gray Iron: ASTM A 48/A 48M, Class 35, unless otherwise indicated.
 3. Include indented top design with lettering cast into cover, using wording equivalent to the following:
 - a. Grease Interceptors in Sanitary Sewerage System: "GREASE INTERCEPTOR" or "SANITARY SEWER" accordingly."
 - b. Oil Interceptors in Sanitary Sewerage System: "OIL INTERCEPTOR" or "SANITARY SEWER" accordingly."

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.2 INSTALLATION

- A. Equipment Mounting:
 - 1. Install grease interceptors, grease removal devices and solids interceptors on cast-in-place concrete equipment base(s).
 - 2. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete." and/or Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."
- B. Install precast concrete interceptors according to ASTM C 891.
- C. Set interceptors level and plumb.
- D. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.
- E. Set tops of manhole frames and covers flush with finished surface in pavements.
 - 1. Set tops 3 inches above finish surface elsewhere unless otherwise indicated.
- F. Set tops of grating frames and grates flush with finished surface.
- G. Set metal and plastic interceptors level and plumb.
- H. Set tops of metal interceptor covers flush with finished surface in pavements.
 - 1. Set tops 3 inches above finish surface elsewhere unless otherwise indicated.
- I. Install piping and oil storage tanks according to Section 23 11 13 "Facility Fuel-Oil Piping."
- J. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
 - 1. Above-Floor Installation: Set unit with bottom resting on floor unless otherwise indicated.
 - 2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
 - 3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
 - 4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.
- K. Install grease removal devices on floor. Install trap, vent, and flow-control fitting according to authorities having jurisdiction.
 - 1. Install control panel adjacent to unit unless otherwise indicated.
- L. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
 - 1. Coordinate oil-interceptor storage tank and gravity drain with Section 23 11 13 "Facility Fuel-Oil Piping."
- M. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet.
 - 1. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in Section 22 13 16 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Make piping connections between interceptors and piping systems.

3.4 IDENTIFICATION

- A. Identification materials and installation are specified in Section 31 20 00 "Earth Moving."
 - 1. Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
 - 2. Use warning tapes or detectable warning tape over ferrous piping.
 - 3. Use detectable warning tape over nonferrous piping and over edges of underground structures.



- B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Grease interceptors.
 - 2. Grease removal devices.
 - 3. Oil interceptors.
 - 4. Solids interceptors.

3.5 PROTECTION

- A. Protect sanitary waste interceptors from damage during construction period.
- B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

END OF SECTION 22 13 23

**SECTION 22 13 29
SANITARY SEWERAGE PUMPS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Submersible effluent pumps.
 - 2. Submersible sewage pumps.
 - 3. Wet-pit-volute sewage pumps.
 - 4. Sewage-pump, reverse-flow assemblies.
 - 5. Sewage-pump basins and basin covers.
 - 6. Progressing-cavity sewage pumps.
 - 7. Packaged, submersible sewage-pump units.
 - 8. Packaged wastewater-pump units.
- B. Related Requirements:
 - 1. Section 22 14 29 "Sump Pumps" for applications in storm-drainage systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and [mounting] [attachment] details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 4. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with manufacturer's written instructions for handling.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.2 SUBMERSIBLE EFFLUENT PUMPS

- A. Submersible, Fixed-Position, Single-Seal Effluent Pumps:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Barnes; a Crane Pumps & Systems brand.
 - b. Grundfos Pumps Corp.
 - c. Liberty Pumps.
 - d. Zoeller Company.
 2. Description: Factory-assembled and -tested effluent-pump unit.
 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
 4. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
 5. Impeller: Statically and dynamically balanced, **[ASTM A 48/A 48M, Class No. 25 A cast iron] [ASTM A 532/A 532M, abrasion-resistant cast iron] [ASTM B 584, cast bronze] [and] [stainless steel]**, closed or semiopen design for clear wastewater, and keyed and secured to shaft.
 6. Pump and Motor Shaft: Stainless steel **[or steel]**, with factory-sealed, grease-lubricated ball bearings.
 7. Seal: Mechanical.
 8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: **[Air] [Oil]**.
 9. Controls:
 - a. Enclosure: NEMA 250, **[Type 1] [Type 4X] <Insert type>**.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
 10. Controls:
 - a. Enclosure: NEMA 250, **[Type 1] [Type 4X] <Insert type>**; **[pedestal] [wall]** mounted.
 - b. Switch Type: **[Mechanical-float] [Mercury-float] [Pressure] <Insert type>** type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with **[mechanical-float, mercury-float, or pressure] <Insert type>** switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
 11. Control-Interface Features:
 - a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.
- B. Submersible, Fixed-Position, Double-Seal Effluent Pumps:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. HOMA Pump Technology Inc.
 - b. Pentair Pump Group.

- c. WILO-EMU USA LLC.
- d. Zoeller Company.
- 2. Description: Factory-assembled and -tested effluent-pump unit.
- 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
- 4. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
- 5. Impeller: Statically and dynamically balanced, [**ASTM A 48/A 48M, Class No. 25 A cast iron**] [**ASTM A 532/A 532M, abrasion-resistant cast iron**] [**ASTM B 584, cast bronze**] [**and**] [**stainless steel**], closed or semiopen design for clear wastewater, and keyed and secured to shaft.
- 6. Pump and Motor Shaft: Stainless steel [**or steel**], with factory-sealed, grease-lubricated ball bearings.
- 7. Seals: Mechanical.
- 8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
- 9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: [**Air**] [**Oil**].
- 10. Controls:
 - a. Enclosure: NEMA 250, [**Type 1**] [**Type 4X**] **<Insert type>**.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
- 11. Controls:
 - a. Enclosure: NEMA 250, [**Type 1**] [**Type 4X**] **<Insert type>**; [**pedestal**] [**wall**] mounted.
 - b. Switch Type: [**Mechanical-float**] [**Mercury-float**] [**Pressure**] **<Insert type>** type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**] **<Insert type>** switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
- 12. Control-Interface Features:
 - a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.
- C. Submersible, Quick-Disconnect, Single-Seal Effluent Pumps:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Pentair Pump Group.
 - b. Stancor, Inc.
 - c. WILO-EMU USA LLC.
 - d. Zoeller Company.
 - 2. Description: Factory-assembled and -tested effluent-pump unit with guide-rail supports.
 - 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.

4. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
5. Impeller: Statically and dynamically balanced, [ASTM A 48/A 48M, Class No. 25 A cast iron] [ASTM A 532/A 532M, abrasion-resistant cast iron] [ASTM B 584, cast bronze] [and] [stainless steel], closed or semiopen design for clear wastewater, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel [or steel], with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: [Air] [Oil].
9. Controls:
 - a. Enclosure: NEMA 250, [Type 1] [Type 4X] <Insert type>.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
10. Controls:
 - a. Enclosure: NEMA 250, [Type 1] [Type 4X] <Insert type>; [pedestal] [wall] mounted.
 - b. Switch Type: [Mechanical-float] [Mercury-float] [Pressure] <Insert type> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [mechanical-float, mercury-float, or pressure] <Insert type> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
11. Control-Interface Features:
 - a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.
12. Guide-Rail Supports:
 - a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
 - b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
 - c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
 - d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
 - e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
 - f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
 - g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.
 - h. Submersible, Quick-Disconnect, Double-Seal Effluent Pumps <Insert drawing designation>:
13. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. HOMA Pump Technology Inc.
 - b. Pentair Pump Group.

- c. WILO-EMU USA LLC.
- d. Zoeller Company.
- 14. Description: Factory-assembled and -tested effluent-pump unit with guide-rail supports.
- 15. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
- 16. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
- 17. Impeller: Statically and dynamically balanced, [**ASTM A 48/A 48M, Class No. 25 A cast iron**] [**ASTM A 532/A 532M, abrasion-resistant cast iron**] [**ASTM B 584, cast bronze**] [**and**] [**stainless steel**], closed or semiopen design for clear wastewater, and keyed and secured to shaft.
- 18. Pump and Motor Shaft: Stainless steel [**or steel**], with factory-sealed, grease-lubricated ball bearings.
- 19. Seals: Mechanical.
- 20. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
- 21. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: [**Air**] [**Oil**].
- 22. Controls:
 - a. Enclosure: NEMA 250, [**Type 1**] [**Type 4X**] <Insert type>.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
- 23. Controls:
 - a. Enclosure: NEMA 250, [**Type 1**] [**Type 4X**] <Insert type>; [**pedestal**] [**wall**] mounted.
 - b. Switch Type: [**Mechanical-float**] [**Mercury-float**] [**Pressure**] <Insert type> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**] <Insert type> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
- 24. Control-Interface Features:
 - a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.
- 25. Guide-Rail Supports:
 - a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
 - b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
 - c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
 - d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
 - e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
 - f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.

- g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.
- D. Capacities and Characteristics:
 - 1. Unit Capacity: <Insert value> gpm.
 - 2. Number of Pumps: [One] [Two] <Insert value>.
 - 3. Each Pump:
 - a. Capacity: <Insert value> gpm.
 - b. Solids Handling Capability: [Not applicable] [2 inches minimum] [2-1/2 inches minimum] [3 inches minimum] <Insert inches minimum>.
 - c. Total Dynamic Head: <Insert value>feet.
 - d. Speed: <Insert rpm>.
 - e. Discharge Pipe Size: <Insert value> NPS.
 - f. Motor Horsepower: <Insert value> hp.
 - g. Electrical Characteristics:
 - 1) Volts: [120] [240] [277] [480] <Insert value> V ac.
 - 2) Phases: [Single] [Three].
 - 3) Hertz: 60.
 - 4. Unit Electrical Characteristics:
 - a. Full-Load Amperes: <Insert value> A.
 - b. Minimum Circuit Ampacity: <Insert value> A.
 - c. Maximum Overcurrent Protection: <Insert value> A.

2.3 SUBMERSIBLE SEWAGE PUMPS

- A. Submersible, Fixed-Position, Single-Seal Sewage Pumps <Insert drawing designation>:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Barnes; a Crane Pumps & Systems brand.
 - b. Liberty Pumps.
 - c. Weil Pump Company, Inc.
 - d. Zoeller Company.
 - 2. Description: Factory-assembled and -tested sewage-pump unit.
 - 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
 - 4. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
 - 5. Impeller: Statically and dynamically balanced, [ASTM A 48/A 48M, Class No. 25 A cast iron] [ASTM A 532/A 532M, abrasion-resistant cast iron] [ASTM B 584, cast bronze] [and] [stainless steel], nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
 - 6. Pump and Motor Shaft: Stainless steel [or steel], with factory-sealed, grease-lubricated ball bearings.
 - 7. Seal: Mechanical.
 - 8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: [Air] [Oil].
 - 9. Controls:
 - a. Enclosure: NEMA 250, [Type 1] [Type 4X] <Insert type>.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.

- e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
- 10. Controls:
 - a. Enclosure: NEMA 250, [Type 1] [Type 4X] <Insert type>; [pedestal] [wall] mounted.
 - b. Switch Type: [Mechanical-float] [Mercury-float] [Pressure] <Insert type> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [mechanical-float, mercury-float, or pressure] <Insert type> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
- 11. Control-Interface Features:
 - a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.
- B. Submersible, Fixed-Position, Double-Seal Sewage Pumps:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Barnes; a Crane Pumps & Systems brand.
 - b. HOMA Pump Technology Inc.
 - c. Weil Pump Company, Inc.
 - d. Zoeller Company.
 - 2. Description: Factory-assembled and -tested sewage-pump unit.
 - 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
 - 4. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
 - 5. Impeller: Statically and dynamically balanced, [ASTM A 48/A 48M, Class No. 25 A cast iron] [ASTM A 532/A 532M, abrasion-resistant cast iron] [ASTM B 584, cast bronze] [and] [stainless steel], nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
 - 6. Pump and Motor Shaft: Stainless steel [or steel], with factory-sealed, grease-lubricated ball bearings.
 - 7. Seals: Mechanical.
 - 8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
 - 9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: [Air] [Oil].
 - 10. Controls:
 - a. Enclosure: NEMA 250, [Type 1] [Type 4X] <Insert type>.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
 - 11. Controls:
 - a. Enclosure: NEMA 250, [Type 1] [Type 4X] <Insert type>; [pedestal] [wall] mounted.

- b. Switch Type: **[Mechanical-float] [Mercury-float] [Pressure]** <Insert type> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with **[mechanical-float, mercury-float, or pressure]** <Insert type> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
12. Control-Interface Features:
- a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.
- C. Submersible, Quick-Disconnect, Single-Seal Sewage Pumps:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. EBARA Fluid Handling.
 - b. Weil Pump Company, Inc.
 - c. WILO-EMU USA LLC.
 - d. Zoeller Company.
 - 2. Description: Factory-assembled and -tested sewage-pump unit with guide-rail supports.
 - 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
 - 4. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
 - 5. Impeller: Statically and dynamically balanced, **[ASTM A 48/A 48M, Class No. 25 A cast iron] [ASTM A 532/A 532M, abrasion-resistant cast iron] [ASTM B 584, cast bronze] [and] [stainless steel]**, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
 - 6. Pump and Motor Shaft: Stainless steel **[or steel]**, with factory-sealed, grease-lubricated ball bearings.
 - 7. Seal: Mechanical.
 - 8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: **[Air] [Oil]**.
 - 9. Controls:
 - a. Enclosure: NEMA 250, **[Type 1] [Type 4X]** <Insert type>.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
 - 10. Controls:
 - a. Enclosure: NEMA 250, **[Type 1] [Type 4X]** <Insert type>; **[pedestal] [wall]** mounted.
 - b. Switch Type: **[Mechanical-float] [Mercury-float] [Pressure]** <Insert type> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with **[mechanical-float, mercury-float, or pressure]** <Insert type> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

11. Control-Interface Features:
 - a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.
12. Guide-Rail Supports:
 - a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
 - b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
 - c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
 - d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
 - e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
 - f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
 - g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.
 - h. Submersible, Quick-Disconnect, Double-Seal Sewage Pumps <Insert drawing designation>:
13. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Barnes; a Crane Pumps & Systems brand.
 - b. HOMA Pump Technology Inc.
 - c. Weil Pump Company, Inc.
 - d. Zoeller Company.
14. Description: Factory-assembled and -tested sewage-pump unit with guide-rail supports.
15. Pump type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
16. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
17. Impeller: Statically and dynamically balanced, [**ASTM A 48/A 48M, Class No. 25 A cast iron**] [**ASTM A 532/A 532M, abrasion-resistant cast iron**] [**ASTM B 584, cast bronze**] [and] [**stainless steel**], nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
18. Pump and Motor Shaft: Stainless steel [**or steel**], with factory-sealed, grease-lubricated ball bearings.
19. Seals: Mechanical.
20. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
21. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: [**Air**] [**Oil**].
22. Controls:
 - a. Enclosure: NEMA 250, [**Type 1**] [**Type 4X**] <Insert type>.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
23. Controls:
 - a. Enclosure: NEMA 250, [**Type 1**] [**Type 4X**] <Insert type>; [**pedestal**] [**wall**] mounted.

- b. Switch Type: **[Mechanical-float] [Mercury-float] [Pressure]** <Insert type> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with **[mechanical-float, mercury-float, or pressure]** <Insert type> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
24. Control-Interface Features:
- a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.
25. Guide-Rail Supports:
- a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
 - b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
 - c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
 - d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
 - e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
 - f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
 - g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.
- D. Submersible, Quick-Disconnect, Grinder Sewage Pumps:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Barnes; a Crane Pumps & Systems brand.
 - b. HOMA Pump Technology Inc.
 - c. Weil Pump Company, Inc.
 - d. Zoeller Company.
 - 2. Description: Factory-assembled and -tested, grinder sewage-pump unit with guide-rail supports.
 - 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
 - 4. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail supports.
 - 5. Impeller: Bronze or stainless steel; statically and dynamically balanced, with stainless-steel cutter, grinder, or slicer assembly; capable of handling solids; and keyed and secured to shaft.
 - 6. Pump and Motor Shaft: Stainless steel **[or steel]**, with factory-sealed, grease-lubricated ball bearings.
 - 7. Seal: Mechanical.
 - 8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: **[Air] [Oil]**.
 - 9. Controls:
 - a. Enclosure: NEMA 250, **[Type 1] [Type 4X]** <Insert type>.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.

- e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
- 10. Controls:
 - a. Enclosure: NEMA 250, [Type 1] [Type 4X] <Insert type>; [pedestal] [wall] mounted.
 - b. Switch Type: [Mechanical-float] [Mercury-float] [Pressure] <Insert type> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [mechanical-float, mercury-float, or pressure] <Insert type> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
- 11. Control-Interface Features:
 - a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.
- 12. Guide-Rail Supports:
 - a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
 - b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
 - c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
 - d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
 - e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
 - f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
 - g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.
- E. Submersible, Quick-Disconnect, Progressing-Cavity, Grinder Sewage Pumps:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Barnes; a Crane Pumps & Systems brand.
 - b. Environment One Corporation.
 - c. Pentair Pump Group.
 - 2. Description: Factory-assembled and -tested, progressing-cavity, grinder sewage-pump unit with guide-rail supports.
 - 3. Pump Type: Submersible, progressing-cavity, single-screw rotary, grinder sewage pump as defined in HI 3.1-3.5.
 - 4. Pump Body: [Cast iron] <Insert material>.
 - 5. Pump Bearings: Radial and thrust types.
 - 6. Pump Shaft: Steel.
 - 7. Rotor: Stainless steel.
 - 8. Stator: [Buna-N] [or] [natural rubber] <Insert material>.
 - 9. Seal: Packing gland and mechanical types.
 - 10. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - 11. Controls:
 - a. Enclosure: NEMA 250, [Type 1] [Type 4X] <Insert type>.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.

- c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
12. Controls:
- a. Enclosure: NEMA 250, [Type 1] [Type 4X] <Insert type>; [pedestal] [wall] mounted.
 - b. Switch Type: [Mechanical-float] [Mercury-float] [Pressure] <Insert type> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [mechanical-float, mercury-float, or pressure] <Insert type> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
13. Control-Interface Features:
- a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.
14. Guide-Rail Supports:
- a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
 - b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
 - c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
 - d. Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
 - e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
 - f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
 - g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.
- F. Capacities and Characteristics:
- 1. Unit Capacity: <Insert value> gpm.
 - 2. Number of Pumps: [One] [Two] <Insert value>.
 - 3. Each Pump:
 - a. Capacity: <Insert value> gpm.
 - b. Solids Handling Capability: [Not applicable] [2 inches minimum] [2-1/2 inches minimum] [3 inches minimum] <Insert inches minimum>.
 - c. Total Dynamic Head: <Insert value> feet.
 - d. Speed: <Insert rpm>.
 - e. Discharge Pipe Size: <Insert value> NPS.
 - f. Motor Horsepower: <Insert value> hp.
 - g. Electrical Characteristics:
 - 1) Volts: [120] [240] [277] [480] <Insert value> V ac.
 - 2) Phases: [Single] [Three].
 - 3) Hertz: 60.
 - 4. Unit Electrical Characteristics:
 - a. Full-Load Amperes: <Insert value> A.
 - b. Minimum Circuit Ampacity: <Insert value> A.
 - c. Maximum Overcurrent Protection: <Insert value> A.

2.4 WET-PIT-VOLUTE SEWAGE PUMPS

- A. Description: Factory-assembled and -tested sewage-pump unit.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Armstrong Pumps, Inc.
 - 2. PACO Pumps; Grundfos Pumps Corporation, USA.
 - 3. Peerless Pump Company.
 - 4. Weil Pump Company, Inc.
- C. Pump Type: Wet-pit-volute, single-stage, separately coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
- D. Pump Casing: Cast iron, with open inlet and threaded or flanged connection for discharge piping.
- E. Pump Shaft: **[Stainless steel] [and] [steel]**.
- F. Impeller: Statically and dynamically balanced, **[ASTM A 48/A 48M, Class No. 25 A cast iron] [ASTM A 532/A 532M, abrasion-resistant cast iron] [and] [ASTM B 584, cast bronze]**, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
- G. Sleeve Bearings: Bronze. Include oil-lubricated, intermediate sleeve bearings at 48-inch-maximum intervals if basin depth is more than 48 inches, and grease-lubricated, ball-type thrust bearings.
- H. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
- I. Pump Discharge Piping: Factory or field fabricated, **[galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.1, Class 125, cast-iron flanges and flanged fittings or ASME B16.4, Class 125, gray-iron threaded fittings] <Insert pipe material>**.
 - 1. Revise piping configuration to accommodate reverse-flow assembly.
- J. Support Plate: Cast iron or coated steel; strong enough to support pumps, motors, and controls. See "Sewage-Pump Basins and Basin Covers" Article for requirements.
- K. Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.
- L. Motor: Single speed; grease-lubricated ball bearings and mounted on vertical, cast-iron pedestal.
- M. Controls:
 - 1. Enclosure: NEMA 250, **[Type 1] [Type 4X] <Insert type>**.
 - 2. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - 3. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - 4. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - 5. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
- N. Controls:
 - 1. Enclosure: NEMA 250, **[Type 1] [Type 4X] <Insert type>**; **[pedestal] [wall]** mounted.
 - 2. Switch Type: **[Mechanical-float] [Mercury-float] [Pressure] <Insert type>** type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - 3. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - 4. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with **[mechanical-float, mercury-float, or pressure] <Insert type>** switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
- O. Control-Interface Features:
 - 1. Remote Alarm Contacts: For remote alarm interface.

2. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - a. On-off status of pump.
 - b. Alarm status.
- P. Capacities and Characteristics:
 1. Unit Capacity: <Insert value> gpm.
 2. Number of Pumps: [One] [Two] <Insert value>.
 3. Each Pump:
 - a. Capacity: <Insert value> gpm.
 - b. Solids Handling Capability: [2 inches] [2-1/2 inches] [3 inches] <Insert inches> minimum.
 - c. Total Dynamic Head: <Insert value> feet.
 - d. Speed: <Insert rpm>.
 - e. Discharge Pipe Size: <Insert value> NPS.
 - f. Motor Horsepower: <Insert value> hp.
 - g. Electrical Characteristics:
 - 1) Volts: [120] [240] [277] [480] <Insert value> V ac.
 - 2) Phases: [Single] [Three].
 - 3) Hertz: 60.
 4. Unit Electrical Characteristics:
 - a. Full-Load Amperes: <Insert value> A.
 - b. Minimum Circuit Ampacity: <Insert value> A.
 - c. Maximum Overcurrent Protection: <Insert value> A.

2.5 SEWAGE-PUMP, REVERSE-FLOW ASSEMBLIES

- A. Description: Factory-fabricated, sewage pump reverse-flow assembly for factory or field assembly and installation in sewage pump basin.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Chicago Pump Company; Grundfos Pumps Corporation.
 2. PACO Pumps; Grundfos Pumps Corporation, USA.
 3. Peerless Pump Company.
 4. Weil Pump Company, Inc.
- C. Components: Include the following corrosion-resistant-metal components:
 1. Inlet Fitting: One combination inlet-overflow strainer fitting.
 2. Valves: Two shutoff valves and two check valves.
 3. Strainers: Two strainer housings with reverse-flow, self-flushing strainers.
 4. Pipe and Fittings: Size and configuration required to connect to sewage pumps and piping.

2.6 SEWAGE-PUMP BASINS AND BASIN COVERS

- A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.
 1. Material: [Cast iron] [Fiberglass] [Polyethylene] <Insert material>.
 2. Reinforcement: Mounting plates for pumps, fittings[, **guide-rail supports if used,**] and accessories.
 3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.
- B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
 1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.
- C. Capacities and Characteristics:
 1. Capacity: <Insert value> gal..

2. Diameter: **<Insert value>** inches.
3. Depth: **<Insert value>** inches.
4. Inlet No. 1:
 - a. Drainage Pipe Size: **<Insert value>** NPS.
 - b. Bottom of Sump to Centerline: **<Insert value>** inches.
 - c. Type: **[Flanged] [Hubbed] [Threaded]** outside.
5. Inlet No. 2:
 - a. Drainage Pipe Size: **<Insert value>** NPS.
 - b. Bottom of Sump to Centerline: **<Insert value>** inches.
 - c. Type: **[Flanged] [Hubbed] [Threaded]** outside.
6. Inlet No. 3:
 - a. Drainage Pipe Size: **<Insert value>** NPS.
 - b. Bottom of Sump to Centerline: **<Insert value>** inches.
 - c. Type: **[Flanged] [Hubbed] [Threaded]** outside.
7. Sidewall Outlet:
 - a. Discharge Pipe Size: **<Insert value>** NPS.
 - b. Bottom of Sump to Centerline: **<Insert value>** inches.
 - c. Type: **[Hubbed inside] [Hubbed outside] <Insert type>**.
8. Cover Material: **[Cast iron] [Steel with bituminous coating] [Cast iron or steel with bituminous coating] <Insert material>**.
9. Cover Diameter: **<Insert value>** inches, but not less than outside diameter of basin top flange.
10. Manhole Required in Cover: **[Yes] [No]**.
11. Vent Size: **<Insert value>** NPS.

2.7 PROGRESSING-CAVITY SEWAGE PUMPS

- A. Description: Factory-assembled and -tested, progressing-cavity, single-screw rotary pump as defined in HI 3.1-3.5.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Continental Pump Co.
 2. Moyno, Inc.
 3. Roper Pump Co.
- C. Pump Body: **[Cast iron] <Insert material>** with feet for base or floor installation.
- D. Pump Bearings: Radial and thrust types.
- E. Pump Shaft: Steel.
- F. Rotor: **[Chrome-plated steel] <Insert material>**.
- G. Stator: **[Buna-N] [or] [natural rubber] <Insert material>**.
- H. Seals: Packing gland and mechanical types.
- I. Coupling: Flexible.
- J. Motor: Single speed; grease-lubricated ball bearings.
- K. Capacities and Characteristics:
 1. Capacity: **<Insert value>**gal..
 2. Solids Handling Capability: **[Not applicable] [2 inches minimum] [2-1/2 inches minimum] [3 inches minimum] <Insert inches minimum>**.
 3. Total Dynamic Head: **<Insert value>** feet.
 4. Speed: **<Insert rpm>**.
 5. Discharge Pipe Size: **<Insert value>** NPS.
 6. Motor Horsepower: **<Insert value>** hp.
 7. Electrical Characteristics:

- a. Volts: [120] [240] [277] [480] <Insert value> V ac.
- b. Phases: [Single] [Three].
- c. Hertz: 60.
8. Unit Electrical Characteristics:
 - a. Full-Load Amperes: <Insert value> A.
 - b. Minimum Circuit Ampacity: <Insert value> A.
 - c. Maximum Overcurrent Protection: <Insert value> A.

2.8 PACKAGED, SUBMERSIBLE SEWAGE-PUMP UNITS

- A. Packaged, Submersible, Grinder, Sewage-Pump Units:
 1. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, grinder sewage-pump unit.
 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Barnes; a Crane Pumps & Systems brand.
 - b. Liberty Pumps.
 - c. Pentair Pump Group.
 - d. Zoeller Company.
 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
 4. Pump Casing: Cast iron.
 5. Impeller: Stainless-steel grinder[, **cutter, or slicer**] type with shredding ring.
 6. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 7. Controls: Manufacturer's standard panel for one pump.
 8. Controls: Automatic, with mechanical- or mercury-float switches and alternator.
 9. Pump Discharge Piping: Factory or field fabricated, [**galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings**] <Insert pipe material>.
 10. Basin: Watertight [**plastic**] and of size required for pumps, with inlet pipe connection and gastight cover with pump discharge and vent connections.
- B. Packaged, Submersible, Nonclog, Sewage-Pump Units:
 1. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sewage-pump unit.
 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Barnes; a Crane Pumps & Systems brand.
 - b. Liberty Pumps.
 - c. Little Giant Pump Co.
 - d. Zoeller Company.
 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
 4. Pump Casing: Cast iron.
 5. Impeller: Brass or cast iron; statically and dynamically balanced, non-clog design, and capable of handling 2-inch-diameter solids.
 6. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 7. Control: Manufacturer's standard panel for one pump.
 8. Controls: Automatic, with mechanical- or mercury-float switches and alternator.
 9. Pump Discharge Piping: Factory or field fabricated, [**galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings**] <Insert pipe material>.



10. Basin: Watertight [**plastic**] and of size required for pumps, with inlet pipe connection and gastight cover with pump discharge and vent connections.
- C. Capacities and Characteristics:
 1. System Capacity: <Insert value>gal..
 2. Number of Pumps: [**One**] [**Two**].
 3. Each Pump:
 - a. Capacity: <Insert value>gal..
 - b. Total Dynamic Head: <Insert value> feet.
 - c. Speed: <Insert rpm>.
 - d. Discharge Pipe Size: <Insert value> NPS.
 - e. Motor Horsepower: <Insert value> hp.
 - f. Electrical Characteristics:
 - 1) Volts: [**120**] [**240**] [**277**] [**480**] <Insert value> V ac.
 - 2) Phases: [**Single**] [**Three**].
 - 3) Hertz: 60.
 4. Unit Electrical Characteristics:
 - a. Full-Load Amperes: <Insert value> A.
 - b. Minimum Circuit Ampacity: <Insert value> A.
 - c. Maximum Overcurrent Protection: <Insert value> A.
 5. Alternator Control Required: [**Yes**] [**No**].
 6. Basin:
 - a. Dimensions: <Insert values>.
 - b. Inlet Size: <Insert value> NPS.
 - c. Bottom to Inlet Centerline: <Insert value> inches.
 - d. Vent Size: <Insert value> NPS.

2.9 PACKAGED WASTEWATER-PUMP UNITS

- A. Packaged, Wet-Pit-Volute, Wastewater-Pump Units:
 1. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, effluent-pump unit.
 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Alyan Pump Company.
 - b. Federal Pump Corp.
 - c. Hartell Pumps; Milton Roy.
 3. Pump Type: Wet-pit-volute, single-stage, separately coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
 4. Pump Body and Impeller: Corrosion-resistant materials.
 5. Motor: With built-in overload protection and mounted vertically on basin cover.
 6. Power Cord: Three-conductor, waterproof cable of length required, but not less than 72 inches and with grounding plug and cable-sealing assembly for connection at pump.
 7. Control: Float switch.
 8. Pump Discharge Piping: Factory or field fabricated, [**galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings**] <Insert pipe material>.
 9. Basin: Watertight, aluminum, plastic, or coated steel with inlet pipe connection and gastight cover with vent and pump discharge connections.
- B. Packaged, Submersible Wastewater-Pump Units:
 1. Description: Factory-assembled and -tested, automatic-operation, effluent-pump unit with basin.
 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Bell & Gossett; a Xylem brand.



- b. Liberty Pumps.
- c. Little Giant Pump Co.
- d. Zoeller Company.
3. Pump Type: Submersible, end-suction, single-stage, overhung-impeller, centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Body and Impeller: Corrosion-resistant materials.
5. Pump Seals: Mechanical.
6. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
7. Power Cord: Three-conductor, waterproof cable of length required, but not less than 72 inches and with grounding plug and cable-sealing assembly for connection at pump.
8. Control: Float switch.
9. Pump Discharge Piping: Factory or field fabricated, **[galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings]** <Insert pipe material>.
10. Basin: Watertight plastic with inlet pipe connection and gastight cover with vent and pump discharge connections.
11. Capacities and Characteristics:
 - a. Pump Capacity: <Insert value> gpm.
 - b. Total Dynamic Head: <Insert value> feet.
 - c. Speed: <Insert rpm>.
 - d. Discharge Pipe Size: <Insert value> NPS.
 - e. Motor Horsepower: <Insert value> hp.
 - f. Electrical Characteristics:
 - 1) Volts: **[120] [240]** <Insert value> V ac.
 - 2) Phases: **[Single] [Three]**.
 - 3) Hertz: 60.
 - g. Unit Electrical Characteristics:
 - 1) Full-Load Amperes: <Insert value> A.
 - 2) Minimum Circuit Ampacity: <Insert value> A.
 - 3) Maximum Overcurrent Protection: <Insert value> A.
 - h. Basin:
 - 1) Capacity: **[2 gal.] [4 gal.]** <Insert value> minimum.
 - 2) Inlet Connection: **[NPS 1-1/2]** <Insert pipe size> minimum.
 - 3) Vent Connection: **[NPS 1-1/2]** <Insert pipe size> minimum.

2.10 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22 05 13 "Common Motor Requirements for Plumbing Equipment."
 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation and filling are specified in Section 31 20 00 "Earth Moving."

3.2 EXAMINATION

- A. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

3.3 INSTALLATION

- A. Pump Installation Standards:
 1. Comply with HI 1.4 for installation of centrifugal pumps.

2. Comply with HI 3.1-3.5 for installation of progressing-cavity sewage pumps.
- B. Equipment Mounting:
 1. Install progressing-cavity sewage pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in [Section 03 30 00 "Cast-in-Place Concrete."] [Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."]
 2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 3. Comply with requirements for vibration isolation devices specified in Section 22 05 48.13 "Vibration Controls for Plumbing Piping and Equipment."
- C. Wiring Method: Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.4 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
 1. Perform each visual and mechanical inspection.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Pumps and controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

- A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust control set points.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 22 13 29



**SECTION 22 14 13
STORM DRAINAGE PIPING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Ductile-iron pipe and fittings.
 - 2. Copper tube and fittings.
 - 3. ABS pipe and fittings.
 - 4. PVC pipe and fittings.
 - 5. Specialty pipe and fittings.
 - 6. Encasement for underground metal piping.
- B. Related Requirements:
 - 1. Section 221429 "Sump Pumps" for storm drainage pumps.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For controlled-flow roof drainage system. Include calculations, plans, and details.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Detail storm drainage piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which drainage piping will be attached or suspended from.
- B. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 FIELD CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Architect, Construction Manager and Owner no fewer than two days in advance of proposed interruption of storm drainage service.
 - 2. Do not proceed with interruption of storm drainage service without Architect's, Construction Manager's and Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.
 - 2. Storm Drainage, Force-Main Piping: 100 psig.



2.2 DUCTILE-IRON PIPE AND FITTING

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. American Ductile Iron Pipe.
 - 2. McWane Ductile.
 - 3. U.S. Pipe and Foundry Company.
- B. Ductile-Iron, Mechanical-Joint Piping:
 - 1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
 - 3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- C. Ductile-Iron, Push-on-Joint Piping:
 - 1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
 - 3. Gaskets: AWWA C111/A21.11, rubber.
- D. Ductile-Iron, Grooved-Joint Piping:
 - 1. Ductile-Iron Pipe: AWWA C151/A21.51, with round-cut-grooved ends according to AWWA C606.
 - 2. Appurtenances in "Ductile-Iron, Grooved-End Pipe Appurtenances" Subparagraph below are available in NPS 4 to NPS 24 (DN 100 to DN 600).
 - 3. Ductile-Iron, Grooved-End Pipe Appurtenances:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Anvil International.
 - 2) Shurjoint Piping Products USA Inc.
 - 3) Smith-Cooper International.
 - 4) Victaulic Company.
 - b. Grooved-End, Ductile-Iron Fittings: ASTM A 536, ductile-iron castings with dimensions matching AWWA C110/A21.10, ductile-iron pipe or AWWA C153/A21.53, ductile-iron fittings; complying with AWWA C606 for grooved ends.
 - c. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.3 COPPER TUBE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Cambridge-Lee Industries, LLC.
 - 2. Cerro Flow Products, LLC.
 - 3. Mueller Industries, Inc.
 - 4. Wieland Copper Products, LLC.
- B. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.
- C. Copper Drainage Fittings: ASME B16.23, cast-copper fittings or ASME B16.29, wrought-copper, solder-joint fittings.
- D. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.



- E. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.
- F. Copper Pressure Fittings:
 - 1. Copper Fittings: ASME B16.18, cast-copper-alloy fittings or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- G. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- H. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.4 ABS PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Charlotte Pipe and Foundry Company.
 - 2. JM Eagle.
 - 3. Mueller Industries, Inc.
- B. NSF Marking: Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
- C. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
- D. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.
- E. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.
- F. Solvent Cement: ASTM D 2235.
 - 1. Solvent cement shall have a VOC content of 325 g/L or less.
 - 2. Solvent cement shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 PVC PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Charlotte Pipe and Foundry Company.
 - 2. GF Piping Systems.
 - 3. JM Eagle.
 - 4. Mueller Industries, Inc.
- B. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
- C. Solid-Wall PVC Pipe: ASTM D 2665; drain, waste, and vent.
- D. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
- E. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- F. Adhesive Primer: ASTM F 656.
 - 1. Adhesive primer shall have a VOC content of 550 g/L or less.
 - 2. Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."



- G. Solvent Cement: ASTM D 2564.
 - 1. Solvent cement shall have a VOC content of 510 g/L or less.

2.6 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
 - 3. Unshielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers of-fering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Mission Rubber Company, LLC; a division of MCP Industries.
 - 4) Plastic Oddities.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric sleeve, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 - 4. Shielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers of-fering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company, LLC; a division of MCP Industries.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.
 - 5. Pressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers of-fering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) EBAA Iron, Inc.
 - 3) JCM Industries, Inc.
 - 4) Romac Industries, Inc.
 - b. Standard: AWWA C219.
 - c. Description: Metal, sleeve-type couplings same size as pipes to be joined, and with pressure rating at least equal to and ends compatible with pipes to be joined.
 - d. Center-Sleeve Material: Manufacturer's standard.
 - e. Gasket Material: Natural or synthetic rubber.
 - f. Metal Component Finish: Corrosion-resistant coating or material.



- B. Dielectric Fittings:
1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
 2. Dielectric Unions:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers of-fering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) A.Y. McDonald Mfg. Co.
 - 2) HART Industrial Unions, LLC.
 - 3) Matco-Norca.
 - 4) WATTS.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 150 psig minimum at 180 deg F.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
 3. Dielectric Flanges:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers of-fering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Central Plastics Company.
 - 2) Matco-Norca.
 - 3) WATTS.
 - 4) Zurn Industries, LLC.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 150 psig minimum at 180 deg F.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded sol-der-joint copper alloy and threaded ferrous.
 4. Dielectric-Flange Insulating Kits:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers of-fering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Advance Products & Systems, Inc.
 - 2) Calpico, Inc.
 - 3) Central Plastics Company.
 - 4) GPT; an EnPro Industries company.
 - b. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig.
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel-backing washers.
 5. Dielectric Nipples:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers of-fering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Grinnell Mechanical Products.
 - 2) Matco-Norca.



- 3) Precision Plumbing Products.
- 4) Victaulic Company.
- b. Description: Electroplated steel nipple.
- c. Standard: IAPMO PS 66.
- d. Pressure Rating: 300 psig at 225 deg F.
- e. End Connections: Male threaded or grooved.
- f. Lining: Inert and noncorrosive, propylene.

2.7 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Retain this article if corrosion protection is required for underground metal piping.
- B. Standard: ASTM A 674 or AWWA C105/A 21.5.
- C. Material: High-density, crosslaminated polyethylene film of 0.004-inch or [linear low-density polyethylene film of 0.008-inch minimum thickness.
- D. Form: Sheet or tube.
- E. Color: Black or natural.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 - 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 - 2. Install piping as indicated unless deviations from layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
 - 1. Do not change direction of flow more than 90 degrees.
 - 2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of drainage piping in direction of flow is prohibited.



- L. Lay buried building piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
- M. Install piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 or 2 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Storm Drainage Piping: 2 percent downward in direction of flow.
- N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Retain subparagraph below if piping will be in corrosive soil.
 - 2. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- O. Install steel piping according to applicable plumbing code.
- P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- Q. Install engineered controlled-flow drain specialties and storm drainage piping in locations indicated.
- R. Install underground, ductile-iron, force-main piping according to AWWA C600.
 - 1. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints.
 - 2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 - 3. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- S. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
 - 1. Retain subparagraph below if piping will be in corrosive soil.
 - 2. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- T. Install force mains at elevations indicated.
- U. Plumbing Specialties:
 - 1. Install backwater valves in storm drainage gravity-flow piping.
 - a. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."
 - 2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
 - 3. Install drains in storm drainage gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."
- V. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- W. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs.



1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
 1. Cut threads full and clean using sharp dies.
 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - c. Do not use pipe sections that have cracked or open welds.
- B. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- C. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- E. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendices.
 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendices.
- F. Joint Restraints and Sway Bracing:
 1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
 - a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
 - b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
 - c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 1. Install transition couplings at joints of piping with small differences in ODs.
 2. In Drainage Piping: Unshielded or Shielded, nonpressure transition couplings.
 3. In Aboveground Force-Main Piping: Fitting-type transition couplings.
 4. In Underground Force-Main Piping:
 - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
 - b. NPS 2 and Larger: Pressure transition couplings.
- B. Dielectric Fittings:
 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.



2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or nipples.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

- A. General valve installation requirements for general-duty valve installations are specified in the following Sections:
 1. Section 220523 "General Duty Valves for Plumbing Piping."
- B. Shutoff Valves:
 1. Install shutoff valve on each sump pump discharge.
 2. Install full port ball valve for piping NS 2 and smaller.
 3. Install gate valve for piping NPS 2-1/2 and larger.
- C. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
 2. Install backwater valves in accessible locations.
 3. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.



- 8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.
- G. Install supports for vertical steel piping every 15 feet.
- H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 5. NPS 6: 10 feet with 5/8-inch rod.
 - 6. NPS 8: 10 feet with 3/4-inch rod.
- I. Install supports for vertical copper tubing every 10 feet.
- J. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
 - 1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
 - 2. Install horizontal backwater valves with cleanout cover and in pit with pit cover flush with floor.
 - 3. Comply with requirements for backwater valves, cleanouts and drains specified in Section 221423 "Storm Drainage Piping Specialties."
- D. Connect force-main piping to the following:
 - 1. Storm Sewer: To exterior force main.
 - 2. Sump Pumps: To sump pump discharge.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance.
- F. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

- A. Identify exposed storm drainage piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:



1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 3. Test Procedure:
 - a. Test storm drainage piping, on completion of roughing-in.
 - b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 5. Prepare reports for tests and required corrective action.
- C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.
- D. Piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
 1. Copper Type DWV tube, copper drainage fittings, and soldered joints.
 2. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.
- C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:
 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 2. Copper Type DWV tube, copper drainage fittings, and soldered joints.
 3. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.
- D. Underground storm drainage piping NPS 6 and smaller shall be any of the following:



1. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 3. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.
- E. Underground, storm drainage piping NPS 8 and larger shall be any of the following:
1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 2. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
 3. Dissimilar Pipe-Material Couplings: [Unshielded] [Shielded], nonpressure transition couplings.
- F. Aboveground storm drainage force mains NPS 1-1/2 and NPS 2 shall be any of the following:
1. Hard copper tube, Type L copper pressure fittings, and soldered joints.
 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
- G. Aboveground storm drainage force mains NPS 2-1/2 to NPS 6 shall be any of the following:
1. Hard copper tube, Type L copper pressure fittings, and soldered joints.
 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
 3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
 4. Fitting-type transition couplings if dissimilar pipe materials.
- H. Underground storm drainage force mains NPS 4 and smaller shall be any of the following:
1. Hard copper tube; Type L wrought-copper pressure fittings; and soldered joints.
 2. Ductile-iron, mechanical-joint piping and mechanical joints.
 3. Ductile-iron, push-on-joint piping and push-on joints.
 4. Ductile-iron, grooved-joint piping and grooved joints.
 5. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.
- I. Underground storm drainage force mains NPS 5 and larger shall be any of the following:
1. Hard copper tube; Type L wrought-copper pressure fittings; and soldered joints.
 2. Ductile-iron, mechanical-joint piping and mechanical joints.
 3. Ductile-iron, push-on-joint piping and push-on joints.
 4. Ductile-iron, grooved-joint piping and grooved joints.
 5. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION 22 14 13

SECTION 22 14 23
STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal roof drains.
 - 2. Miscellaneous storm drainage piping specialties.
 - 3. Cleanouts.
 - 4. Backwater valves.
 - 5. Trench drains.
 - 6. Channel drainage systems.
- B. Related Requirements:
 - 1. Section 07 62 00 "Sheet Metal Flashing and Trim" for penetrations of roofs.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

- A. Cast-Iron, Large-Sump, General-Purpose Roof Drains:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. Wade; a subsidiary of McWane Inc.
 - d. WATTS.
 - 2. Standard: ASME A112.6.4.
 - 3. Body Material: Cast iron.
 - 4. Dimension of Body: Nominal 14-to 16-inch diameter.
 - 5. Combination Flashing Ring and Gravel Stop: As Required.
 - 6. Flow-Control Weirs: As Required.
 - 7. Outlet: Bottom.
 - 8. Outlet Type: No hub or Threaded.
 - 9. Extension Collars: As Required.
 - 10. Underdeck Clamp: As Required.
 - 11. Expansion Joint: As Required.
 - 12. Sump Receiver Plate: As Required.
 - 13. Dome Material: Aluminum or Stainless Steel.
 - 14. Perforated Gravel Guard: Stainless steel.
 - 15. Vandal-Proof Dome: Required.
 - 16. Water Dam: 2 inches high on Overflow Drains.



- B. Cast-Iron, Medium-Sump, General-Purpose Roof Drains:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. Wade; a subsidiary of McWane Inc.
 - d. WATTS.
 2. Standard: ASME A112.6.4.
 3. Body Material: Cast iron.
 4. Dimension of Body: 8- to 12-inch diameter.
 5. Combination Flashing Ring and Gravel Stop: As Required.
 6. Flow-Control Weirs: As Required.
 7. Outlet: Bottom.
 8. Outlet Type: No hub or Threaded.
 9. Extension Collars: As Required.
 10. Underdeck Clamp: As Required.
 11. Expansion Joint: As Required.
 12. Sump Receiver Plate: As Required.
 13. Dome Material: Aluminum or Stainless Steel.
 14. Wire Mesh: Stainless steel or brass over dome.
 15. Perforated Gravel Guard: Stainless steel.
 16. Vandal-Proof Dome: As Required.
 17. Water Dam: 2 inches high om Overflow drains.
- C. Cast-Iron, Small-Sump, General-Purpose Roof Drains:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. Wade; a subsidiary of McWane Inc.
 - d. WATTS.
 2. Standard: ASME A112.6.4.
 3. Body Material: Cast iron.
 4. Dimension of Body: Nominal 8-inch diameter.
 5. Combination Flashing Ring and Gravel Stop: [Not required] [Required].
 6. Outlet: Bottom or Side.
 7. Outlet Type: No hub or Threaded.
 8. Extension Collars: As Required.
 9. Underdeck Clamp: As Required.
 10. Expansion Joint: As Required.
 11. Sump Receiver Plate: As Required.
 12. Dome Material: Cast iron.
 13. Wire Mesh: Stainless steel or brass over dome.
 14. Vandal-Proof Dome: Required.
- D. Metal, **Cornice and Gutter** Roof Drains:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. Wade; a subsidiary of McWane Inc.
 - d. WATTS.



2. Standard: ASME A112.6.4.
 3. Body Material: Cast iron.
 4. Dimension of Body: Nominal 6-inch diameter.
 5. Outlet: Bottom, Side or 45-degree angle.
 6. Outlet Type: Threaded.
 7. Dome Material: Bronze.
 8. Wire Mesh: Stainless steel or brass over dome.
 9. Vandal-Proof Dome: Required.
- E. Metal, Parapet Roof Drains:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. Wade; a subsidiary of McWane Inc.
 - d. WATTS.
 2. Standard: ASME A112.6.4.
 3. Body Material: Cast iron.
 4. Outlet: Back or Angle.
 5. Outlet Type: Threaded.
 6. Grate Material: Bronze or Nickel-bronze alloy.
 7. Wire Mesh: Stainless steel or brass over grate.
 8. Vandal-Proof Grate: Required.
- F. Metal, Large-Sump, Promenade Roof Drains:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. WATTS.
 2. Standard: ASME A112.6.4.
 3. Body Material: Cast iron.
 4. Dimension of Body: Nominal 12- to 14-inch diameter.
 5. Dimension of Frame and Grate: Nominal 12 to 14 inches square.
 6. Outlet: Bottom or Side.
 7. Outlet Type: No hub or Threaded.
 8. Grate Material: Bronze or Nickel-bronze alloy.
 9. Vandal-Proof Grate: Required.
 10. Extension Collars: As Required.
 11. Underdeck Clamp: As Required.
 12. Expansion Joint: As Required.
 13. Sump Receiver Plate: As Required.
- G. Metal, Medium-Sump, Promenade Roof Drains:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. Wade; a subsidiary of McWane Inc.
 - d. Zurn Industries, LLC.
 2. Standard: ASME A112.6.4.



3. Body Material: Cast iron.
 4. Dimension of Body: 11- to 12-inch diameter.
 5. Dimension of Frame and Grate: Nominal 12 inches square.
 6. Outlet: Bottom or Side.
 7. Outlet Type: No hub or Threaded.
 8. Grate Material: Bronze or Nickel-bronze alloy.
 9. Vandal-Proof Grate: As Required.
 10. Extension Collars: As Required.
 11. Underdeck Clamp: As Required.
 12. Expansion Joint: As Required.
 13. Sump Receiver Plate: As Required.
- H. Metal, Small-Sump, Promenade Roof Drains:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. Wade; a subsidiary of McWane Inc.
 - d. WATTS.
 2. Standard: ASME A112.6.4.
 3. Body Material: Cast iron.
 4. Dimension of Body: Nominal 8-inch diameter.
 5. Dimension of Frame and Grate: Nominal 8 inches square.
 6. Outlet: Bottom.
 7. Outlet Type: No hub or Threaded.
 8. Grate Material: Bronze or Nickel-bronze alloy.
 9. Vandal-Proof Grate: As Required.
 10. Extension Collars: As Required.
 11. Underdeck Clamp: As Required.
 12. Expansion Joint: As Required.
 13. Sump Receiver Plate: As Required.
- I. Metal, Medium-Sump, Deck Roof Drains:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. Wade; a subsidiary of McWane Inc.
 - d. WATTS.
 2. Standard: ASME A112.6.4.
 3. Body Material: Cast iron.
 4. Flange: Anchor with weep holes as required.
 5. Clamping Device: As Required.
 6. Integral Backwater Valve: As Required.
 7. Outlet: Bottom or Side.
 8. Outlet Type: No hub or Threaded.
 9. Grate Material: Cast or ductile iron.
 10. Grate Finish: Stainless Steel.
 11. Overall Dimension of Frame and Grate: Nominal 12 to 14 inches round or square.
 12. Top-Loading Classification: Heavy Duty.
 13. Vandal-Proof Frame and Grate: Required.



- J. Metal, Small-Sump, Deck Roof Drains:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. WATTS.
 - 2. Standard: ASME A112.6.4.
 - 3. Body Material: Metal.
 - 4. Flange: Anchor with weep holes as required.
 - 5. Clamping Device: As Required.
 - 6. Integral Backwater Valve: As Required.
 - 7. Outlet: Bottom or Side.
 - 8. Outlet Type: No hub or Threaded.
 - 9. Grate Material: Cast or ductile iron.
 - 10. Grate Finish: Stainless Steel.
 - 11. Overall Dimension of Frame and Grate: Nominal 8 inches round or square.
 - 12. Top-Loading Classification: As Required.
 - 13. Vandal-Proof Frame and Grate: Required.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

- A. Downspout Adaptors:
 - 1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
 - 2. Size: Inlet size to match parapet drain outlet.
- B. Downspout Boots:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. J.R. Hoe & Sons Inc.
 - b. Neenah Foundry Company.
 - 2. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
 - 3. Size: Inlet size to match downspout and NPS 4 outlet.
- C. Conductor Nozzles:
 - 1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
 - 2. Size: Same as connected conductor.

2.3 CLEANOUTS

- A. Cast-Iron Exposed Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. Wade; a subsidiary of McWane Inc.
 - d. WATTS.
 - 2. Standard: ASME A112.36.2M.
 - 3. Size: Same as connected branch.
 - 4. Body Material: No-hub, cast-iron soil pipe test tee as required to match connected piping.
 - 5. Closure: Countersunk or raised-head, brass plug.
 - 6. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.



- B. Cast-Iron Exposed Floor Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. Wade; a subsidiary of McWane Inc.
 - d. WATTS.
 - 2. Standard: ASME A112.36.2M.
 - 3. Size: Same as connected branch.
 - 4. Type: Heavy-duty, adjustable housing or Threaded, adjustable housing.
 - 5. Body or Ferrule: Cast iron.
 - 6. Clamping Device: As Required.
 - 7. Outlet Connection: No hub, Hub with gasket or Threaded.
 - 8. Closure: Brass plug with straight threads and gasket or Brass plug with tapered threads.
 - 9. Adjustable Housing Material: Cast iron with threads or setscrews.
 - 10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy or Painted cast iron.
 - 11. Frame and Cover Shape: Round. Square where requested by owner.
 - 12. Top Loading Classification: Extra-Heavy or Heavy duty for exterior locations. Light or Medium Duty for location within building.
 - 13. Riser: ASTM A 74, Extra-Heavy or Service class, cast-iron drainage pipe fitting and riser to cleanout.
- C. Cast-Iron Wall Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. Wade; a subsidiary of McWane Inc.
 - d. WATTS.
 - 2. Standard: ASME A112.36.2M. Include wall access.
 - 3. Size: Same as connected drainage piping.
 - 4. Body: No-hub, cast-iron soil pipe test tee as required to match connected piping.
 - 5. Closure Plug:
 - a. Brass.
 - b. Countersunk head.
 - c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as, or not more than, one size smaller than cleanout size.
 - 6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
 - 7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.
- D. Test Tees:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. WATTS.
 - 2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301.
 - 3. Size: Same as connected drainage piping.
 - 4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or no-hub, cast-iron soil-pipe test tee as required to match connected piping.
 - 5. Closure Plug: Countersunk or raised head, brass.

6. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

2.4 BACKWATER VALVES

A. Cast-Iron, Horizontal Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. MIFAB, Inc.
 - c. Wade; a subsidiary of McWane Inc.
 - d. WATTS.
2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body Material: Cast iron.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: Hub and spigot or no hub.
7. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
8. Extension: ASTM A 74, Service class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Cast-Iron, Drain-Outlet Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. WATTS.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.14.1.
3. Size: Same as floor drain outlet.
4. Body Material: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
5. Check Valve: Removable ball float.
6. Inlet: Threaded.
7. Outlet: Threaded or spigot.

2.5 TRENCH DRAINS

A. Trench Drains:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. WATTS.
2. Standard: ASME A112.6.3.
3. Body Material: Cast iron.
4. Flange: Anchor, Seepage as required.
5. Clamping Device: As Required.
6. Outlet: Bottom, End or Side.
7. Outlet Type: Inside caulk.
8. Grate Material: Stainless Steel.
9. Grate Finish: Stainless Steel.
10. Dimensions of Frame and Grate: Refer to Plumbing Fixture Schedule on Constructions Plans for body, sump, and grate requirements.

11. Top-Loading Classification: Extra-Heavy or Heavy for exterior locations. Light to Medium Duty for locations within the building.

2.6 CHANNEL DRAINAGE SYSTEMS

- A. Narrow, Sloped-Invert, Polymer-Concrete, Channel Drainage Systems:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ACO USA.
 - b. Jay R. Smith Mfg. Co.
 - c. MultiDrain Systems, Inc.
 - d. Polycast: Hubbell Power Systems, Inc.
 2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 - a. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.
 - 1) Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
 - 2) Include extension sections necessary for required depth.
 - 3) Dimensions: 5-inch inside width and 9-3/4-inch inside depth. Include number of units required to form total lengths indicated.
 - 4) Frame: Galvanized steel or cast iron for grates.
 - b. Grates: Manufacturer's designation "heavy or medium duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
 - 1) Material: Galvanized steel or Stainless steel.
 - 2) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 - c. Covers: Stainless Steel, of width and thickness that fit recesses in channel sections, and of lengths indicated.
 - d. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
 - e. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- B. Narrow, Level-Invert, Polymer-Concrete, Channel Drainage Systems:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ABT, Inc.
 - b. ACO USA.
 - c. Mea-Josam Div.
 - d. Polycast: Hubbell Power Systems, Inc.
 2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 - a. Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps.
 - 1) Include rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
 - 2) Dimensions: 5-inch inside width and 9-3/4-inch inside depth. Include number of units required to form total lengths indicated.
 - 3) Frame: Galvanized steel or cast iron for grates].
 - b. Grates: Manufacturer's designation heavy or medium duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
 - 1) Material: Galvanized steel or Stainless steel.
 - 2) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

- c. Covers: Solid ductile or cast iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
- d. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
- e. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
 - 1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Install expansion joints, if indicated, in roof drain outlets.
 - 3. Position roof drains for easy access and maintenance.
- B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.
- C. Install downspout boots at grade with top 12 inches above grade. Secure to building wall.
- D. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- E. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
 - 1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 - 3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate cleanouts at base of each vertical storm piping conductor.
- F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- H. Install horizontal backwater valves in floor with cover flush with floor.
- I. Install drain-outlet backwater valves in outlet of drains.
- J. Install test tees in vertical conductors and near floor.
- K. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- L. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.
- M. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- N. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.
 - 1. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 14 13 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.



- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 14 23

**SECTION 22 14 29
SUMP PUMPS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Submersible sump pumps.
 - 2. Wet-pit-volute sump pumps.
 - 3. Sump-pump basins and basin covers.
 - 4. Packaged drainage-pump units.
- B. Related Requirements:
 - 1. Section 22 13 29 "Sanitary Sewerage Pumps" for effluent and sewage pumps.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and [mounting] [attachment] details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 4. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.2 SUBMERSIBLE SUMP PUMPS

- A. Submersible, Fixed-Position, Single-Seal Sump Pumps:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Barnes; a Crane Pumps & Systems brand.
 - b. Liberty Pumps.
 - c. Weil Pump Company, Inc.
 - d. Zoeller Company.

2. Description: Factory-assembled and -tested sump-pump unit.
 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
 4. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
 5. Impeller: Statically and dynamically balanced, [ASTM A 48/A 48M, Class No. 25 A cast iron] [ASTM A 532/A 532M, abrasion-resistant cast iron] [and] [ASTM B 584, cast bronze], [semiopen] <Insert design> design for clear wastewater handling, and keyed and secured to shaft.
 6. Pump and Motor Shaft: Stainless steel [or steel], with factory-sealed, grease-lubricated ball bearings.
 7. Seal: Mechanical.
 8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: [Air] [Oil].
 9. Controls:
 - a. Enclosure: NEMA 250, [Type 1] [Type 4X] <Insert type>.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
 10. Controls:
 - a. Enclosure: NEMA 250, [Type 1] [Type 4X] <Insert type>; [pedestal] [wall] mounted.
 - b. Switch Type: [Mechanical-float] [Mercury-float] [Pressure] <Insert type> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [mechanical-float, mercury-float, or pressure] <Insert type> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
 11. Control-Interface Features:
 - a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.
- B. Submersible, Fixed-Position, Double-Seal Sump Pumps:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. BJM Pumps, LLC.
 - b. EBARA Fluid Handling.
 - c. Flygt; a brand of Xylem Inc.
 - d. PACO Pumps; Grundfos Pumps Corporation, USA.
 2. Description: Factory-assembled and -tested sump-pump unit.
 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
 4. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.

5. Impeller: Statically and dynamically balanced, [**ASTM A 48/A 48M, Class No. 25 A cast iron**] [**ASTM A 532/A 532M, abrasion-resistant cast iron**] [and] [**ASTM B 584, cast bronze**], [**semiopen**] <Insert design> design for clear wastewater handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel [**or steel**], with factory-sealed, grease-lubricated ball bearings.
7. Seals: Mechanical.
8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: [**Air**] [**Oil**].
10. Controls:
 - a. Enclosure: NEMA 250, [**Type 1**] [**Type 4X**] <Insert type>.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
11. Controls:
 - a. Enclosure: NEMA 250, [**Type 1**] [**Type 4X**] <Insert type>; [**pedestal**] [**wall**] mounted.
 - b. Switch Type: [**Mechanical-float**] [**Mercury-float**] [**Pressure**] <Insert type> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with [**mechanical-float, mercury-float, or pressure**] <Insert type> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
12. Control-Interface Features:
 - a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.

2.3 WET-PIT-VOLUTE SUMP PUMPS

- A. Description: Factory-assembled and -tested sump-pump unit.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Armstrong Pumps, Inc.
 2. PACO Pumps; Grundfos Pumps Corporation, USA.
 3. Pentair Pump Group.
 4. Weil Pump Company, Inc.
- C. Pump Type: Wet-pit-volute, single-stage, separately coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
- D. Pump Casing: Cast iron, with strainer inlet and threaded connection for NPS 2 and smaller and flanged connection for NPS 2-1/2 and larger discharge piping.
- E. Impeller: Statically and dynamically balanced, [**ASTM A 48/A 48M, Class No. 25 A cast iron**] [**ASTM A 532/A 532M, abrasion-resistant cast iron**] [and] [**ASTM B 584, cast bronze**], [**semiopen**] <Insert design> design for clear wastewater handling, and keyed and secured to shaft.



- F. Sleeve Bearings: Bronze. Include oil-lubricated, intermediate sleeve bearings at 48-inch-maximum intervals if basin depth is more than 48 inches, and grease-lubricated, ball-type thrust bearings.
- G. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
- H. Pump Discharge Piping: Factory or field fabricated, **[galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.1, Class 125, cast-iron flanges and flanged fittings or ASME B16.4, Class 125, gray-iron threaded fittings]** <Insert pipe material>.
- I. Support Plate: Cast iron or coated steel; strong enough to support pumps, motors, and controls. See "Sump-Pump Basins and Basin Covers" Article for requirements.
- J. Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.
- K. Motor: Single speed; grease-lubricated ball bearings and mounting on vertical, cast-iron pedestal.
- L. Controls:
 - 1. Enclosure: NEMA 250, **[Type 1] [Type 4X]** <Insert type>.
 - 2. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - 3. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - 4. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - 5. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
- M. Controls:
 - 1. Enclosure: NEMA 250, **[Type 1] [Type 4X]** <Insert type>; **[pedestal] [wall]** mounted.
 - 2. Switch Type: **[Mechanical-float] [Mercury-float] [Pressure]** <Insert type> type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - 3. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - 4. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with **[mechanical-float, mercury-float, or pressure]** <Insert type> switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
- N. Control-Interface Features:
 - 1. Remote Alarm Contacts: For remote alarm interface.
 - 2. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - a. On-off status of pump.
 - b. Alarm status.

2.4 SUMP-PUMP CAPACITIES AND CHARACTERISTICS

- A. Unit Capacity: <Insert value> gpm.
- B. Number of Pumps: **[One] [Two]** <Insert number>.
- C. Each Pump:
 - 1. Capacity: <Insert value> gpm.
 - 2. Total Dynamic Head: <Insert value> feet.
 - 3. Speed: <Insert rpm>.
 - 4. Discharge Size: <Insert value> NPS.
 - 5. Electrical Characteristics:
 - a. Motor Horsepower: <Insert value> hp.
 - b. Volts: **[120] [240] [277] [480]** <Insert value> V ac.
 - c. Phases: **[Single] [Three]**.
 - d. Hertz: 60.
- D. Unit Electrical Characteristics:

1. Full-Load Amperes: <Insert value> A.
2. Minimum Circuit Ampacity: <Insert value> A.
3. Maximum Overcurrent Protection: <Insert value> A.

2.5 SUMP-PUMP BASINS AND BASIN COVERS

- A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.
 1. Material: **[Cast iron] [Fiberglass] [Polyethylene]** <Insert material>.
 2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
 3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.
- B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
 1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.
- C. Capacities and Characteristics:
 1. Capacity: <Insert value> gal..
 2. Diameter: <Insert value> inches.
 3. Depth: <Insert value> inches.
 4. Inlet No. 1:
 - a. Drainage Pipe Size: <Insert value> NPS.
 - b. Bottom of Sump to Centerline: <Insert value> inches.
 - c. Type: **[Flanged] [Hubbed] [Threaded]** outside.
 5. Inlet No. 2:
 - a. Drainage Pipe Size: <Insert value> NPS.
 - b. Bottom of Sump to Centerline: <Insert value> inches.
 - c. Type: **[Flanged] [Hubbed] [Threaded]** outside.
 6. Inlet No. 3:
 - a. Drainage Pipe Size: <Insert value> NPS.
 - b. Bottom of Sump to Centerline: <Insert value> inches.
 - c. Type: **[Flanged] [Hubbed] [Threaded]** outside.
 7. Sidewall Outlet:
 - a. Discharge Pipe Size: <Insert value> NPS.
 - b. Bottom of Sump to Centerline: <Insert value> inches.
 - c. Type: **[Hubbed inside] [Hubbed outside]** <Insert type>.
 8. Cover Material: **[Cast iron] [Steel with bituminous coating] [Cast iron or steel with bituminous coating]** <Insert material>.
 9. Cover Diameter: <Insert value> inches, but not less than outside diameter of basin top flange.
 10. Manhole Required in Cover: **[Yes] [No]**.
 11. Vent Size: **[Not required] <Insert NPS>**.

2.6 PACKAGED DRAINAGE-PUMP UNITS

- A. Packaged Pedestal Drainage-Pump Units:
 1. Description: Factory-assembled and -tested, automatic-operation, freestanding, sump-pump unit.
 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Liberty Pumps.
 - b. Little Giant Pump Co.
 - c. Pentair Pump Group.
 - d. Zoeller Company.
 3. Pump Type: Wet-pit-volute, single-stage, separately coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.

4. Pump Casing: Corrosion-resistant material, with strainer inlet, design that permits flow into impeller, and vertical discharge for piping connection.
 5. Impeller: Aluminum, brass, or plastic.
 6. Motor: With built-in overload protection and mounted vertically on sump pump column.
 7. Power Cord: Three-conductor, waterproof cable of length required, but not less than 72 inches, with grounding plug and cable-sealing assembly for connection at pump.
 8. Control: Float switch.
- B. Packaged Submersible Drainage-Pump Units <Insert drawing designation>:
1. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sump-pump unit.
 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Grundfos Pumps Corp.
 - b. Liberty Pumps.
 - c. Little Giant Pump Co.
 - d. Zoeller Company.
 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
 4. Casing: **[Metal]** <Insert material>.
 5. Impeller: **[Brass]** <Insert material>.
 6. Pump Seal: Mechanical.
 7. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
 8. Power Cord: Three-conductor, waterproof cable of length required, but not less than 72 inches, with grounding plug and cable-sealing assembly for connection at pump.
 9. Pump Discharge Piping: Factory or field fabricated, **[galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray-iron threaded fittings]** <Insert pipe material>.
 10. Control: Motor-mounted float switch.
 11. Basin: Plastic.
- C. Capacities and Characteristics:
1. Capacity: <Insert value>gpm.
 2. Total Dynamic Head: <Insert value>feet.
 3. Speed: <Insert rpm>.
 4. Discharge Pipe Size: <Insert value>NPS.
 5. Electrical Characteristics:
 - a. Motor Horsepower: <Insert value> hp.
 - b. Volts: **[120] [240] [277] [480]** <Insert value> V.
 - c. Phases: **[Single] [Three]**.
 - d. Hertz: 60.
 - e. Full-Load Amperes: <Insert value> A.
 - f. Minimum Circuit Ampacity: <Insert value> A.
 - g. Maximum Overcurrent Protection: <Insert value> A.
 6. Basin: Not required.
 7. Basin:
 - a. Capacity: **[2 gal.] [5 gal.]** <Insert value> minimum.
 - b. Inlet Connection: **[NPS 1-1/2]** <Insert pipe size> minimum.

2.7 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22 05 13 "Common Motor Requirements for Plumbing Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.



- B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation and filling are specified in Section 31 20 00 "Earth Moving."

3.2 EXAMINATION

- A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.3 INSTALLATION

- A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.4 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 14 13 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Pumps and controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

- A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust control set points.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 22 14 29

SECTION 22 33 00
ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Commercial, electric, domestic-water booster heaters.
 - 2. Commercial, electric, storage, domestic-water heaters.
 - 3. Commercial, light-duty, storage, electric, domestic-water heaters.
 - 4. Flow-control, electric, tankless, domestic-water heaters.
 - 5. Thermostat-control, electric, tankless, domestic-water heaters.
 - 6. Domestic-water heater accessories.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: For commercial domestic-water heaters, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Product Certificates: For each type of commercial and tankless, electric, domestic-water heater, from manufacturer.
- C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.



1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
 - 1. Comply with efficiency requirements in ASHRAE 189.1, which supersede requirements in ASHRAE/IESNA 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Electric, Domestic-Water Booster Heaters:
 - 1) Controls and Other Components: [Three] [Five] <Insert number> years.
 - b. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: [Three] [Five] <Insert number> years.
 - 2) Controls and Other Components: [Three] [Five] <Insert number> years.
 - c. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
 - 1) Storage Tank: [Three] [Five] <Insert number> years.
 - 2) Controls and Other Components: [Two] [Three] <Insert number> years.
 - d. Electric, Tankless, Domestic-Water Heaters: [One] [Two] [Five] <Insert number> year(s).
 - e. Compression Tanks: [Five] <Insert number> years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

- A. Commercial, Electric, Domestic-Water Booster Heaters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradford White Corporation.
 - b. Rheem Manufacturing Company.
 - c. Smith, A. O. Corporation.
 - 2. Standard: UL 1453.
 - 3. Tank Construction: [Corrosion-resistant metal] [or] [steel].
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining material into tappings.
 - 4. Factory-Installed Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.

- b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - c. Insulation: Comply with ASHRAE/IESNA 90.1.
 - d. Jacket: Rectangular shaped, with stainless-steel front panel, unless otherwise indicated.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
 - 1) Option: Booster heaters with total of 9 kW or less may have two or three elements.
 - f. Temperature Control: Adjustable thermostat, to setting of at least 180 deg F.
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valve. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
 - i. Gages: Combination temperature-and-pressure type or separate thermometer and pressure gage.
5. Special Requirements: NSF 5 construction with **[brackets for undercounter]** **[legs for floor]** installation.
- B. Commercial, Electric, Storage, Domestic-Water Heaters:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradford White Corporation.
 - b. Rheem Manufacturing Company.
 - c. Smith, A. O. Corporation.
 - 2. Standard: UL 1453.
 - 3. Storage-Tank Construction: **[Non-]**ASME-code, steel **[horizontal]** **[vertical]** arrangement.
 - a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Pressure Rating: **[150 psig]** **<Insert value>**.
 - c. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining material into tappings.
 - 4. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - c. Insulation: Comply with ASHRAE/IESNA 90.1.
 - d. Jacket: Steel with enameled finish.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
 - f. Temperature Control: Adjustable thermostat.
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
 - 5. Special Requirements: NSF 5 construction.
- C. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradford White Corporation.
 - b. Rheem Manufacturing Company.
 - c. Smith, A. O. Corporation.
 - 2. Standard: UL 174.
 - 3. Storage-Tank Construction: Steel, vertical arrangement.



- a. Tappings: ASME B1.20.1 pipe thread.
- b. Pressure Rating: 150 psig.
- c. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining material into tappings.
4. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1 [or **ASHRAE 90.2**].
 - e. Jacket: Steel with enameled finish.
 - f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
 - g. Heating Elements: Two; electric, screw-in immersion type; wired for simultaneous operation unless otherwise indicated. Limited to 12 kW total.
 - h. Temperature Control: Adjustable thermostat.
 - i. Safety Control: High-temperature-limit cutoff device or system.
 - j. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
5. Special Requirements: NSF 5 construction with legs for off-floor installation.
- D. Capacity and Characteristics:
 1. Capacity: <Insert gal.>.
 2. Recovery: <Insert gph> at [40 deg F] [50 deg F] [100 deg F] <Insert temperature> temperature rise.
 3. Temperature Setting: [125 deg F] [140 deg F] [180 deg F] <Insert temperature>.
 4. Power Demand: <Insert kilowatts>.
 5. Heating Elements:
 - a. Number of Elements: [Two] [Three] [Six] [Nine] <Insert number>.
 - b. Kilowatts Each Element: <Insert kilowatts>.
 - c. Number of Stages: [One] [Two] [Three] [Four] <Insert number>.
 6. Electrical Characteristics:
 - a. Volts: [120] [240] [277] [480] <Insert value>.
 - b. Phases: [Single] [Three].
 - c. Hertz: 60.
 - d. Full-Load Amperes: <Insert value>.
 - e. Minimum Circuit Ampacity: <Insert value>.
 - f. Maximum Overcurrent Protection: <Insert amperage>.

2.2 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

- A. Flow-Control, Electric, Tankless, Domestic-Water Heaters:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bosch Water Heating.
 - b. Chronomite Laboratories, Inc.
 - c. Eemax, Inc.
 - d. Stiebel Eltron, Inc.
 2. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
 3. Construction: Copper piping or tubing complying with NSF 61 Annex G barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: [150 psig] <Insert value>.
 - c. Heating Element: Resistance heating system.

- d. Temperature Control: Flow-control fitting.
 - e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
 - 4. Support: Bracket for wall mounting.
 - 5. Capacity and Characteristics:
 - a. Flow Rate: **<Insert gpm>**.
 - b. Maximum Temperature Setting: **<Insert temperature>**.
 - c. Power Demand: **<Insert kilowatts>**.
 - d. Electrical Characteristics:
 - 1) Volts: **[120] [240] [277] [480] <Insert value>**.
 - 2) Phases: **[Single] [Three]**.
 - 3) Hertz: 60.
 - 4) Full-Load Amperes: **<Insert value>**.
 - 5) Minimum Circuit Ampacity: **<Insert value>**.
 - 6) Maximum Overcurrent Protection: **<Insert amperage>**.
- B. Thermostat-Control, Electric, Tankless, Domestic-Water Heaters:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bosch Water Heating.
 - b. Chronomite Laboratories, Inc.
 - c. E-Tankless Water Heaters Corp.
 - d. Keltech, Inc.
 - 2. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
 - 3. Construction: Copper piping or tubing complying with NSF 61 Annex G barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: **[150 psig] <Insert value>**.
 - c. Heating Element: Resistance heating system.
 - d. Temperature Control: Thermostat.
 - e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
 - 4. Support: Bracket for wall mounting.
 - 5. Capacity and Characteristics:
 - a. Flow Rate: **<Insert gpm>** at **[100 deg F] <Insert temperature>** temperature rise.
 - b. Temperature Setting: **[125 deg F] [140 deg F] <Insert temperature>**.
 - c. Power Demand: **<Insert kilowatts>**.
 - d. Electrical Characteristics:
 - 1) Volts: **[120] [240] [277] [480] <Insert value>**.
 - 2) Phases: **[Single] [Three]**.
 - 3) Hertz: 60.
 - 4) Full-Load Amperes: **<Insert value>**.
 - 5) Minimum Circuit Ampacity: **<Insert value>**.
 - 6) Maximum Overcurrent Protection: **<Insert amperage>**.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

- A. Domestic-Water Compression Tanks:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Flexcon Industries.
 - c. Smith, A. O. Corporation.
 - d. TACO Comfort Solutions, Inc.

2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
3. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
4. Capacity and Characteristics:
 - a. Working-Pressure Rating: **[100 psig] [150 psig] <Insert value>**.
 - b. Capacity Acceptable: **[2 gal.] [4 gal.] [7 gal.] [10 gal.] <Insert value>** minimum.
 - c. Air Precharge Pressure: **<Insert system pressure>**.
- B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.
- D. Heat-Trap Fittings: ASHRAE 90.2.
- E. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and **[calibrated] [memory-stop]** balancing valves to provide balanced flow through each domestic-water heater.
 1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping," Section 22 05 23.13 "Butterfly Valves for Plumbing Piping," and Section 22 05 23.15 "Gate Valves for Plumbing Piping."
 2. Comply with requirements for balancing valves specified in Section 22 11 19 "Domestic Water Piping Specialties."
- F. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig-maximum outlet pressure unless otherwise indicated.
- G. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- H. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.
- I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
- J. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
- K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.
- L. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in [Section 03 30 00 "Cast-in-Place Concrete."] [Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."]
 - 1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 - 2. Maintain manufacturer's recommended clearances.
 - 3. Arrange units so controls and devices that require servicing are accessible.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 8. Anchor domestic-water heaters to substrate.
- B. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters [at least 18 inches above floor] on wall bracket.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Anchor domestic-water heaters to substrate.
- C. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping," Section 22 05 23.13 "Butterfly Valves for Plumbing Piping," and Section 22 05 23.15 "Gate Valves for Plumbing Piping."
- D. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- F. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.



- G. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."
- H. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- I. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 22 05 23 "general Duty Valves for Plumbing Piping" and comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- J. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of 25 psig. Comply with requirements for pressure-reducing valves and water hammer arresters specified in Section 22 11 19 "Domestic Water Piping Specialties."
- K. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- L. Fill electric, domestic-water heaters with water.
- M. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial and tankless, electric, domestic-water heaters.



END OF SECTION 22 33 00



SECTION 22 34 00
FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Commercial, atmospheric, gas-fired, storage, domestic-water heaters.
 - 2. Commercial, power-burner, gas-fired, storage, domestic-water heaters.
 - 3. Commercial, power-vent, gas-fired, storage, domestic-water heaters.
 - 4. Commercial, gas-fired, high-efficiency, storage, domestic-water heaters.
 - 5. Gas-fired, tankless, domestic-water heaters.
 - 6. Domestic-water heater accessories.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Product Certificates: For each type of commercial, gas-fired and gas-fired, tankless domestic-water heater, from manufacturer.
- C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.



1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.
 - 1. Comply with efficiency requirements in ASHRAE 189.1, which supersede requirements in ASHRAE/IESNA 90.1.
- C. ASME Compliance:
 - 1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: One year.
 - b. Commercial, Finned-Tube, Gas-Fired, Domestic-Water Heaters:
 - 1) Heat Exchanger: Three years.
 - 2) Controls and Other Components: One year.
 - 3) Separate Hot-Water Storage Tanks: Three years.
 - c. Gas-Fired, Tankless, Domestic-Water Heaters:
 - 1) Heat Exchanger: Five years.
 - 2) Controls and Other Components: Three years.
 - d. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

- A. Commercial, Atmospheric, Gas-Fired, Storage, Domestic-Water Heaters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradford White Corporation.
 - b. Rheem Manufacturing Company.
 - c. Smith, A. O. Corporation.
 - 2. Standard: ANSI Z21.10.3/CSA 4.3.
 - 3. Storage-Tank Construction: ASME-code steel with 150-psig working-pressure rating.
 - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

- 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
- 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
- b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
- c. Lining: Cement or Glass complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
4. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
 - e. Jacket: Steel with enameled finish.
 - f. Burner: For use with atmospheric, gas-fired, domestic-water heaters and natural-gas fuel.
 - g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
 - h. Temperature Control: Adjustable thermostat.
 - i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
 - j. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
5. Special Requirements: NSF 5 construction.
6. Draft Hood: Draft diverter, complying with ANSI Z21.12.
7. Automatic Damper: ANSI Z21.66/CSA 6.14-M, electrically operated, mechanically activated or thermally activated, automatic-vent-damper device with size matching draft hood.
- B. Commercial, Power-Vent, Gas-Fired, Storage, Domestic-Water Heaters:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradford White Corporation.
 - b. Rheem Manufacturing Company.
 - c. Smith, A. O. Corporation.
 2. Standard: ANSI Z21.10.3/CSA 4.3.
 3. Storage-Tank Construction: ASME-code steel with 150-psig working-pressure rating.
 - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Lining: Cement or Glass complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
 4. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
 - e. Jacket: Steel with enameled finish.
 - f. Burner: For use with power-vent, gas-fired, domestic-water heaters and natural-gas fuel.



- g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
 - h. Temperature Control: Adjustable thermostat.
 - i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
 - j. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
5. Special Requirements: NSF 5 construction.
6. Power-Vent System: Exhaust fan, interlocked with burner.
- C. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradford White Corporation.
 - b. Rheem Manufacturing Company.
 - c. Smith, A. O. Corporation.
 - 2. Standard: ANSI Z21.10.3/CSA 4.3.
 - 3. Description: Manufacturer's proprietary design to provide at least 88 percent combustion efficiency at optimum operating conditions.
 - 4. Storage-Tank Construction: ASME-code steel with 150-psig minimum working-pressure rating.
 - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Lining: Cement or Glass complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
 - 5. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
 - e. Jacket: Steel with enameled finish.
 - f. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and natural-gas fuel.
 - g. Temperature Control: Adjustable thermostat.
 - h. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
 - i. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
 - 6. Draft Hood: Draft diverter, complying with ANSI Z21.12.
- D. Capacity and Characteristics:
- 1. Capacity: Refer to Plumbing Equipment Schedules on Construction Plans.
 - 2. Recovery: <Insert gph> at [100 deg F] <Insert temperature> temperature rise.
 - 3. Temperature Setting: 140 deg F.
 - 4. Fuel Gas Demand: <Insert cfh>.
 - 5. Fuel Gas Input: <Insert Btu/h>.
 - 6. Gas Pressure Regulator:



- a. Capacity: <Insert cfh>.
- b. Inlet Pressure: <Insert psig or inches> water column.
- c. Gas Pressure Required at Burner: <Insert psig or inches> water column.
7. Electrical Characteristics:
 - a. Volts: [120] [240] [277] [480] <Insert value>.
 - b. Phase: [Single] [Three].
 - c. Hertz: 60.
 - d. Full-Load Amperes: <Insert value>.
 - e. Minimum Circuit Ampacity: <Insert value>.
 - f. Maximum Overcurrent Protection: <Insert amperage>.
8. Minimum Vent Diameter: <Insert inches>.

2.2 GAS-FIRED, TANKLESS, DOMESTIC-WATER HEATERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Bosch Water Heating.
 2. NORITZ America Corp.
 3. Rheem Manufacturing Company.
 4. Rinnai Corporation.
- B. Standard: ANSI Z21.10.3/CSA 4.3 for gas-fired, instantaneous, domestic-water heaters for indoor application.
- C. Construction: Copper piping or tubing complying with NSF 61 Annex G barrier materials for potable water, without storage capacity.
 1. Tappings: ASME B1.20.1 pipe thread.
 2. Pressure Rating: 150 psig.
 3. Heat Exchanger: Copper tubing.
 4. Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2.
 5. Jacket: Metal, with enameled finish, or plastic.
 6. Burner: For use with tankless, domestic-water heaters and **natural-gas** fuel.
 7. Automatic Ignition: Manufacturer's proprietary system for automatic, gas ignition.
 8. Temperature Control: Adjustable thermostat.
- D. Support: Bracket for wall mounting.
- E. Capacity and Characteristics:
 1. Flow Rate: <Insert gpm> at [100 deg F] <Insert temperature> temperature rise.
 2. Temperature Setting: **140 deg F**.
 3. Fuel Gas Demand: <Insert cfh>.
 4. Fuel Gas Input: <Insert Btu/h>.
 5. Gas Pressure Regulator:
 - a. Capacity: <Insert cfh>.
 - b. Inlet Pressure: <Insert psig or inches> water column.
 - c. Gas Pressure Required at Burner: <Insert psig or inches> water column.
 6. Electrical Characteristics:
 - a. Volts: [120] <Insert value>.
 - b. Phase: Single.
 - c. Hertz: 60.
 - d. Full-Load Amperes: <Insert value>.
 - e. Minimum Circuit Ampacity: <Insert value>.
 - f. Maximum Overcurrent Protection: <Insert amperage>.
 7. Minimum Vent Diameter: <Insert inches>.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

- A. Domestic-Water Compression Tanks:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Honeywell.
 - c. State Industries.
 - d. TACO Comfort Solutions, Inc.
 - 2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 - 3. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
 - 4. Capacity and Characteristics:
 - a. Working-Pressure Rating: [100 psig] [150 psig] <Insert value>.
 - b. Capacity Acceptable: [2 gal.] [4 gal.] [7 gal.] [10 gal.] <Insert value> minimum.
 - c. Air Precharge Pressure: <Insert system pressure>.
- B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.
- D. Heat-Trap Fittings: ASHRAE 90.2.
- E. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-type shutoff valves to isolate each domestic-water heater and calibrated or memory-stop balancing valves to provide balanced flow through each domestic-water heater.
- F. Comply with requirements for ball, butterfly, or gate-type shutoff valves specified in Section 22 05 23 "General Duty Valves for Plumbing Piping."
 - 1. Comply with requirements for balancing valves specified in Section 22 11 19 "Domestic Water Piping Specialties."
- G. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.
- H. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig pressure rating as required to match gas supply.
- I. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- J. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
 - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
 - 2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.
- K. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.
 - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
 - 2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.
- L. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

- M. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.
- N. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.
- C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 03 30 00 "Cast-in-Place Concrete." or Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."
 - 1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 - 2. Maintain manufacturer's recommended clearances.
 - 3. Arrange units so controls and devices that require servicing are accessible.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 8. Anchor domestic-water heaters to substrate.
- B. Tankless, Domestic-Water Heater Mounting: Install tankless, domestic-water heaters at least 18 inches above floor on wall bracket.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Anchor domestic-water heaters to substrate.
- C. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 05 23 "General Duty Valves for Plumbing Piping."
- D. Install gas-fired, domestic-water heaters according to NFPA 54.
 - 1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.

2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
 3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
 4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 22 10 23 "Facility Natural-Gas Piping."
- E. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 - F. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
 - G. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
 - H. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."
 - I. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."
 - J. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Section 22 05 23 "General Duty Valves for Plumbing Piping" and comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."
 - K. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
 - L. Fill domestic-water heaters with water.
 - M. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

- A. Comply with requirements for domestic-water piping specified in Section 22 11 16 "Domestic Water Piping."
- B. Comply with requirements for gas piping specified in Section 22 10 23 "Facility Natural-Gas Piping."
- C. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.



1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspection requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage and gas-fired, tankless, domestic-water heaters.

END OF SECTION 22 34 00

**SECTION 22 40 00
PLUMBING FIXTURES**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Water closets.
 - 2. Water closet Flushometer valves and tanks.
 - 3. Toilet seats.
 - 4. Urinals.
 - 5. Urinal Flushometer valves.
 - 6. Lavatories.
 - 7. Lavatory Faucets.
 - 8. Service sinks.
 - 9. Utility sinks.
 - 10. Handwash sinks.
 - 11. Sink faucets.
 - 12. Shower faucets.
 - 13. Group Showers.
 - 14. Laminar-flow, faucet-spout outlets.
 - 15. Lavatory and Sink Supply Fittings.
 - 16. Lavatory and Sink Waste Fittings.
 - 17. Grout.
 - 18. Supports.
- B. Related Requirements:
 - 1. Section 22 45 00 "Emergency Plumbing Fixtures" for Eyewash and shower units.
 - 2. Section 22 47 13 "Drinking Fountains" for drinking fountain units.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for all fixtures.
 - 2. Include rated capacities, operating characteristics, electrical characteristics (where applicable), and furnished specialties and accessories.
- B. Sustainable Design Submittals:
 - 1. Product Data: For water consumption.
- C. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fixtures, faucets, flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than five of each type.
 - 2. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.



3. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 WALL-MOUNTED WATER CLOSETS

- A. Water Closets: Wall mounted, top spud.
 1. Manufacturer: Kohler "Kingston" model K-4325 or approved equal.
 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following;
 3. American Standard, Sloan Valve or Zurn Industries.
 4. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flushometer valve.
 - e. Height: Standard.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.28 gal. per flush.
 - h. Spud Size and Location: NPS 1-1/2; top.
 5. Flushometer Valve: See below.
 6. Toilet Seat: See below.
 7. Support: See below.
 8. Water-Closet Mounting Height: Standard or Accessible or per Architectural drawings.
- B. Water Closets: Wall mounted, back spud.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. Kohler Co.
 - c. TOTO USA, INC.
 - d. Zurn Industries, LLC.
 2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flushometer valve.
 - e. Height: Standard.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.28 gal. per flush.
 - h. Spud Size and Location: NPS 1-1/2; back.
 3. Flushometer Valve: See below.
 4. Toilet Seat: See below.
 5. Support: See below.
 6. Water-Closet Mounting Height: Standard or Accessible or per Architectural drawings.

2.2 WATER CLOSET FLUSHOMETER VALVES

- A. Electronic Flushometer Valves:
 1. Manufacturer: Sloan "Royal" model 111-1.28-SF-ESS-TMO-HW or approved equal.
 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following;
 3. American Standard, Sloan Valve or Zurn Industries.
 4. Standard: ASSE 1037.
 5. Type: Diaphragm.
 6. Minimum Pressure Rating: 125 psig.

7. Features: Include integral check stop, backflow-prevention device and True Mechanical override switch.
8. Material: Brass body with corrosion-resistant components.
9. Exposed Flushometer-Valve Finish: Chrome plated.
10. Panel Finish: Chrome plated or stainless steel.
11. Style: Exposed.
12. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
13. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
14. Consumption: 1.28 gal. per flush.
15. Minimum Inlet: NPS 1.
16. Minimum Outlet: NPS 1-1/4.

2.3 TOILET SEATS

A. Toilet Seats:

1. Manufacturer: Olsonite model 95SSCT or approved equal.
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following;
3. Bemis Manufacturing, Church Seats or American Standard.
4. Standard: IAPMO/ANSI Z124.5.
5. Material: Plastic.
6. Type: Commercial, Heavy duty.
7. Shape: Elongated rim, open front.
8. Hinge: Self-sustaining, check-raising.
9. Hinge Material: Noncorroding metal, stainless steel.
10. Seat Cover: Not required.
11. Color: White.

2.4 WALL-HUNG URINALS

A. Urinals: Wall hung, back outlet, Washout.

1. Manufacturer: Kohler "Bardon" model K-4991-ET or approved equal.
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following;
3. American Standard, Sloan Valve or Zurn Industries.
4. Fixture:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Type: Hybrid, Washout.
 - c. Material: Vitreous china.
 - d. Strainer or Trapway: Manufacturer's standard strainer.
 - e. Water Consumption: Water saving.
 - f. Spud Size and Location: NPS 3/4; top.
 - g. Outlet Size and Location: NPS 2; back.
 - h. Color: White.
5. Flushometer Valve: See below.
6. Waste Fitting:
 - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
 - b. Size: NPS 2.
7. Support: Type I Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.
8. Urinal Mounting Height: Standard or Accessible or per Architectural drawings.

B. Waterless Urinals: Not Permitted



2.5 URINAL FLUSHOMETER VALVES

- A. Electronic Flushometer Valves:
1. Manufacturer: Sloan "Royal" model 186-0.125-DBP-SF-ESS-TMO-HW or approved equal.
 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following;
 3. American Standard, Sloan Valve or Zurn Industries.
 4. Standard: ASSE 1037.
 5. Type: Diaphragm.
 6. Minimum Pressure Rating: 125 psig.
 7. Features: Include integral check stop, backflow-prevention device and True Mechanical override switch.
 8. Material: Brass body with corrosion-resistant components.
 9. Exposed Flushometer-Valve Finish: Chrome plated.
 10. Panel Finish: Chrome plated or stainless steel.
 11. Style: Exposed.
 12. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 13. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 14. Consumption: 0.125 gal. per flush.
 15. Minimum Inlet: NPS 3/4.
 16. Minimum Outlet: NPS 3/4.

2.6 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

- A. Lavatory: Rectangular, Round or Oval, self-rimming, vitreous china, counter or undercounter mounted.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Standard.
 - b. Crane Plumbing, L.L.C.
 - c. Gerber Plumbing Fixtures LLC.
 - d. Kohler Co.
 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: Self-rimming for above-counter mounting.
 - c. Nominal Size: Rectangular, **[21 by 19 inches] [24 by 20 inches] <Insert dimensions>**.
 - d. Faucet-Hole Punching: **[One hole] [Three holes, 2-inch centers] [Three holes, 4-inch centers]**.
 - e. Faucet-Hole Location: Top.
 - f. Color: **[White] <Insert color>**.
 - g. Mounting Material: Sealant.
 3. Faucet: **<Insert lavatory faucet designation from "Solid-Brass, Manually Operated Faucets" or "Solid-Brass, Automatically Operated Lavatory Faucets" Article>**.

2.7 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

- A. Lavatory: Vitreous china, wall mounted, with back.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Standard.
 - b. Crane Plumbing, L.L.C.
 - c. Kohler Co.
 - d. Sloan Valve Company.
 2. Fixture:

- a. Standard: ASME A112.19.2/CSA B45.1.
- b. Type: For wall hanging.
- c. Nominal Size: Oval, [19 by 16 inches] [22 by 14 inches] [23 by 15 inches] <Insert dimensions>.
- d. Faucet-Hole Punching: [One hole] [Three holes, 2-inch centers] [Three holes, 4-inch centers].
- e. Faucet-Hole Location: Top.
- f. Color: [White] <Insert color>.
- g. Mounting Material: Chair carrier.
3. Faucet: <Insert lavatory faucet designation from "Solid-Brass, Manually Operated Faucets" or "Solid-Brass, Automatically Operated Lavatory Faucets" Article>.
4. Support: [Type I, exposed-arm lavatory carrier] [Type II, concealed-arm lavatory carrier] [Type II, concealed-arm lavatory carrier with escutcheons].[Include rectangular, steel uprights.]
5. Lavatory Mounting Height: [Standard] [Child] [Handicapped/elderly according to ICC A117.1].

2.8 SOLID-BRASS, MANUALLY OPERATED FAUCETS

- A. NSF Standard: Comply with NSF 372 for faucet materials that will be in contact with potable water.
- B. Lavatory Faucets: Manual-type, [single-control mixing] [single-control nonmixing] [two-handle mixing], [commercial] [general-duty], solid-brass valve.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Chicago Faucets; Geberit Company.
 - b. Delta Faucet Company.
 - c. Moen Incorporated.
 - d. T&S Brass and Bronze Works, Inc.
 2. Standard: ASME A112.18.1/CSA B125.1.
 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 4. Body Type: [Centerset] [Widespread] [Single hole] <Insert type>.
 5. Body Material: Commercial, solid brass.
 6. Finish: [Polished chrome plate] <Insert finish>.
 7. Maximum Flow Rate: [0.5 gpm] <Insert value>.
 8. Maximum Flow: [0.25 gal.] <Insert value> per metering cycle.
 9. Mounting Type: [Deck, exposed] [Deck, concealed] [Back/wall, exposed] [Back/wall, concealed].
 10. Valve Handle(s): [Single lever] [Knob] [Knob, nonmetallic] [Cross, three arm] [Cross, four arm] [Wrist blade, 4 inches] [Elbow, 6 inches] [Push button] <Insert type>.
 11. Spout: [Rigid] [Swing] [Rigid, gooseneck] [Swivel, gooseneck] type.
 12. Spout Outlet: [Aerator] [Laminar flow] [Spray] <Insert type>.
 13. Operation: [Compression, manual] [Noncompression, manual].
 14. Drain: [Not part of faucet] <Insert type>.

2.9 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY FAUCETS

- A. NSF Standard: Comply with NSF 372 for faucet materials that will be in contact with potable water.
- B. Lavatory Faucets: Automatic-type, **hard-wired**, electronic-sensor-operated, [mixing] [nonmixing], solid-brass valve.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. **Sloan**
 - b. **Dyson**
 - c. Chicago Faucets; Geberit Company.

- d. T&S Brass and Bronze Works, Inc.
2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
5. Body Type: **[Single hole]** <Insert type>.
6. Body Material: **[Commercial]** **[General-duty]**, solid brass.
7. Finish: **[Polished chrome plate]** <Insert finish>.
8. Maximum Flow Rate: **[0.5 gpm]** <Insert value>.
9. Mounting Type: **[Deck, concealed]** **[Back/wall, concealed]** <Insert type>.
10. Spout: **[Rigid]** **[Swing]** **[Rigid, gooseneck]** **[Swivel, gooseneck]** type.
11. Spout Outlet: **[Aerator]** **[Laminar flow]** **[Spray]** <Insert type>.
12. Drain: **[Not part of faucet]** <Insert type>.

2.10 SERVICE SINKS

- A. Service Sinks: Enameled, cast iron, trap standard mounted.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Standard.
 - b. Commercial Enameling Company.
 - c. Gerber Plumbing Fixtures LLC.
 - d. Kohler Co.
 2. Fixture:
 - a. Standard: ASME A112.19.1/CSA B45.2.
 - b. Type: Service sink with back.
 - c. Back: **[Two faucet holes]** **[Plain]**.
 - d. Nominal Size: **[22 by 18 inches]** **[24 by 20 inches]**.
 - e. Color: White.
 - f. Mounting: **[NPS 2]** **[NPS 3]** P-trap standard with grid strainer inlet, cleanout, and floor flange.
 - g. Rim Guard: On front and sides.
 3. Faucet: <Insert sink-faucet designation from "Sink Faucets" Article>.
 4. Support: **[Type II sink carrier.]** <Insert carrier>.
 5. Lavatory Mounting Height: **[Standard]** **[Child]** **[Handicapped/elderly according to ICC A117.1]**.
- B. Service Sinks: Enameled, cast iron, floor mounted.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Standard.
 - b. Commercial Enameling Company.
 - c. Gerber Plumbing Fixtures LLC.
 - d. Kohler Co.
 2. Fixture:
 - a. Standard: ASME A112.19.1/CSA B45.2.
 - b. Style: With front apron and raised back.
 - c. Nominal Size: 28 by 28 inches.
 - d. Color: White.
 - e. Drain: Grid with **[NPS 2]** **[NPS 3]** outlet.
 - f. Rim Guard: Coated wire.
 3. Faucet: <Insert sink-faucet designation from "Sink Faucets" Article>.

2.11 UTILITY SINKS

- A. Utility Sinks: Stainless steel, counter mounted.



1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Advance Tabco.
 - b. Eagle Group.
 - c. Elkay Manufacturing Co.
 - d. Just Manufacturing.
 2. Fixture:
 - a. Standard: ASME A112.19.3/CSA B45.4.
 - b. Type: Ledge back.
 - c. Number of Compartments: **[One] [Two] [Three]**.
 - d. Overall Dimensions: **<Insert dimensions>**.
 - e. Metal Thickness: **[0.050 inch] <Insert dimension>**.
 - f. Compartment:
 - 1) Dimensions: **<Insert dimensions>**.
 - 2) Drain: **[Grid with NPS 1-1/2 tailpiece and twist drain] [Grid with NPS 2 tailpiece and twist drain] [NPS 1-1/2 tailpiece with stopper] <Insert drain>**.
 - 3) Drain Location: **[Centered in compartment] [Near back of compartment] [Near left side of compartment] [Near right side of compartment] <Insert location>**.
 - g. Each Compartment:
 - 1) Dimensions: **<Insert dimensions>**.
 - 2) Drains: **[Grid with NPS 1-1/2 tailpiece and twist drain] [Grid with NPS 2 tailpiece and twist drain] [NPS 1-1/2 tailpiece with stopper] <Insert drain>**.
 - 3) Drain Location: **[Centered in compartment] [Near back of compartment] <Insert location>**.
 3. Faucet(s):
 - a. Number Required: **[One] [Two]**.
 - b. Mounting: On ledge.
 4. Mounting: On counter with sealant.
- B. Utility Sinks: Stainless steel, freestanding.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Advance Tabco.
 - b. Eagle Group.
 - c. Elkay Manufacturing Co.
 - d. Just Manufacturing.
 2. Fixture:
 - a. Standard: ASME A112.19.3/CSA B45.4.
 - b. Type: With backsplash.
 - c. Number of Compartments: **[One] [Two] [Three]**.
 - d. Overall Dimensions: **<Insert dimensions>**.
 - e. Metal Thickness: **[0.050 inch] [0.063 inch] <Insert dimension>**.
 - f. Compartment:
 - 1) Dimensions: **<Insert dimensions>**.
 - 2) Drain: **[Grid with NPS 1-1/2 tailpiece and twist drain] [Grid with NPS 2 tailpiece and twist drain] [NPS 1-1/2 tailpiece with stopper] <Insert drain>**.
 - 3) Drain Location: **[Centered in compartment] [Near back of compartment] [Near left side of compartment] [Near right side of compartment] <Insert location>**.
 - g. Each Compartment:
 - 1) Dimensions: **<Insert dimensions>**.
 - 2) Drains: **[Grid with NPS 1-1/2 tailpiece and twist drain] [Grid with NPS 2 tailpiece and twist drain] [NPS 1-1/2 tailpiece with stopper] <Insert drain>**.

- 3) Drain Location: **[Centered in compartment] [Near back of compartment] <Insert location>**.
- h. Drainboard(s): **[Not required] [Both] [Left] [Right] side(s)**.
 - 1) Dimensions Each: **[Not applicable] <Insert dimensions>**.
3. Supports: Adjustable-length steel legs.
4. Faucet(s): **<Insert sink-faucet designation from "Sink Faucets" Article>**.
 - a. Number Required: **[One] [Two]**.
 - b. Mounting: On backsplash.

2.12 HANDWASH SINKS

- A. Handwash Sinks: Stainless steel, wall mounted.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Advance Tabco.
 - b. Eagle Group.
 - c. Elkay Manufacturing Co.
 - d. Just Manufacturing.
 2. Fixture:
 - a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
 - b. Type: Basin with radius corners, back for faucet, and support brackets.
 - c. Nominal Size: 17 by 16 by 5 inches.
 3. Faucet: **<Insert sink-faucet designation from "Sink Faucets" Article>**.
 4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
 5. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
 6. Support: **[Type II sink carrier.]<Insert carrier>**.
 7. Lavatory Mounting Height: **[Standard] [Child] [Handicapped/elderly according to ICC A117.1]**.

2.13 SINK FAUCETS

- A. NSF Standard: Comply with NSF 372 for faucet-spout materials that will be in contact with potable water.
- B. Sink Faucets: Manual type, **[single control] [two lever handle] <Insert type>** mixing valve.
 1. Commercial and General-Duty, Solid-Brass Faucets:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Chicago Faucets; Geberit Company.
 - 2) Delta Faucet Company.
 - 3) Kohler Co.
 - 4) Moen Incorporated.
 - 5) Sloan Valve Company.
 - 6) T&S Brass and Bronze Works, Inc.
 2. Standard: ASME A112.18.1/CSA B125.1.
 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
 4. Body Type: **[Centerset] [Widespread] [Single hole] <Insert type>**.
 5. Body Material: **[Commercial, solid brass] [General-duty, solid brass] [Copper or brass underbody]**.
 6. Finish: **[Chrome plated] [Polished chrome plate] <Insert finish>**.
 7. Maximum Flow Rate: **[2.2 gpm] [4.0 gpm] <Insert value>**.
 8. Handle(s): **[Lever] [Cross, four arm] [Wrist blade, 4 inches] [Elbow, 6 inches] [Not applicable] <Insert handles>**.
 9. Mounting Type: **[Deck, concealed] [Deck, exposed] [Back/wall, exposed]**.



10. Spout Type: **[Rigid, solid brass]** **[Rigid, solid brass with wall brace]** **[Swing, round tubular]** **[Swing, shaped tube]** **[Swing, solid brass]** **[Rigid gooseneck]** **[Swivel gooseneck]** **<Insert type>**.
 11. Vacuum Breaker: **[Required]** **[Not required]** for hose outlet.
 12. Spout Outlet: **[Aerator]** **[Laminar flow]** **[Hose thread according to ASME B1.20.7]** **[Plain end]** **[Spray]** **<Insert type>**.
- C. Sink Faucets: Automatic, sensor-operated type, **[120 V ac hard-wired]** **[battery-powered]** **<Insert type>**, mixing valve.
1. Commercial, Solid-Brass Faucets:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Chicago Faucets; Geberit Company.
 - 2) Delta Faucet Company.
 - 3) Kohler Co.
 - 4) Moen Incorporated.
 - 5) Sloan Valve Company.
 - 6) T&S Brass and Bronze Works, Inc.
 2. Standard: ASME A112.18.1/CSA B125.1.
 3. General: Coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
 4. Body Type: **[Centerset]** **[Single hole]** **<Insert type>**.
 5. Body Material: **[Commercial, solid brass]** **[General-duty, solid brass]**.
 6. Finish: **[Chrome plated]** **[Polished chrome plate]** **<Insert finish>**.
 7. Maximum Flow Rate: **[0.5 gpm]** **<Insert value>**.
 8. Mounting Type: **[Deck]** **[Back/wall]**.
 9. Spout Type: **[Rigid spout]** **[Rigid gooseneck]** **<Insert type>**.
 10. Spout Outlet: **[Aerator]** **[Laminar flow]** **<Insert type>**.
 11. Thermostatic Mixing Valve: **[Above deck,]** **[Below deck,]** **[single temperature]** **[adjustable temperature manual side handle, with hot/cold water indicators]**, with check valves.
 12. Control module: **[Above deck,]** **[Below deck,]** water-resistant module with internal flow setting switches.

2.14 SHOWER FAUCETS

- A. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for shower materials that will be in contact with potable water.
- B. Shower Faucets:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Standard.
 - b. Chicago Faucets; Geberit Company.
 - c. Bradley Co.
 - d. Moen Incorporated.
 - e. Speakman Company.
 2. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and shower head.
 3. Faucet:
 - a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
 - b. Body Material: Solid brass.
 - c. Finish: Polished chrome plate.
 - d. Shower-Arm, Flow-Control Fitting: **[Not required]** **[1.5 gpm]** **[2.0 gpm]** **[2.5 gpm]**.
 - e. EPA WaterSense: Required.
 - f. Mounting: **[Concealed]** **[Exposed]**.

- g. Operation: Single-handle, **[push-pull]** **[or]** **[twist or rotate]** control.
 - h. Antiscald Device: **[Integral with mixing valve]** **[Separate unit]** **[Not required]**.
 - i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
4. Supply Connections: NPS 1/2.
5. Shower Head:
- a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Type: **[Ball joint with arm and flange]** **[Without ball joint, but with arm and flange]** **[Ball joint and head integral with mounting flange]** **[Integral with mounting flange]** **<Insert type>**.
 - c. Shower Head Material: Metallic with chrome-plated finish.
 - d. Spray Pattern: **[Adjustable]** **[Fixed]**.
 - e. Integral Volume Control: **[Not required]** **[Required]**.
 - f. Shower-Arm, Flow-Control Fitting: **[Not required]** **[1.5 gpm]** **[2.0 gpm]**.
 - g. Temperature Indicator: **[Integral with faucet]** **[Not required]**.
- C. Shower Faucets:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
- a. American Standard.
 - b. Chicago Faucets; Geberit Company.
 - c. Bradley Corporation.
 - d. Moen Incorporated.
 - e. Speakman Company.
2. Description: Single-handle, thermostatic mixing valve with hot- and cold-water indicators; check stops; and shower head.
3. Faucet:
- a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
 - b. Body Material: Solid brass.
 - c. Finish: Polished chrome plate.
 - d. Shower-Arm, Flow-Control Fitting: **[Not required]** **[1.5 gpm]** **[2.0 gpm]** **[2.5 gpm]**.
 - e. EPA WaterSense: Required.
 - f. Mounting: **[Concealed]** **[Exposed]**.
 - g. Operation: Single-handle, **[push-pull]** **[or]** **[twist or rotate]** control.
 - h. Antiscald Device: **[Integral with mixing valve]** **[Separate unit]** **[Not required]**.
 - i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
4. Supply Connections: NPS 1/2.
5. Shower Head:
- a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Type: **[Ball joint with arm and flange]** **[Without ball joint, but with arm and flange]** **[Ball joint and head integral with mounting flange]** **[Integral with mounting flange]** **<Insert type>**.
 - c. Shower Head Material: Metallic with chrome-plated finish.
 - d. Spray Pattern: **[Adjustable]** **[Fixed]**.
 - e. Integral Volume Control: **[Not required]** **[Required]**.
 - f. Shower-Arm, Flow-Control Fitting: **[Not required]** **[1.5 gpm]** **[2.0 gpm]**.
 - g. Temperature Indicator: **[Integral with faucet]** **[Not required]**.

2.15 GROUP SHOWERS

- A. Group Column Showers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:



- a. Acorn Engineering Company.
 - b. Bradley Corporation.
 - c. Willoughby Industries.
 2. Description: Stainless-steel, column shower fixture with individual nozzles.
 3. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
 4. Metal Nominal Thickness: **[0.050 inch minimum] [0.063 inch]**.
 5. Number of Shower Nozzles: **[Two] [Three] [Four] [Five] [Six]**.
 6. Height to Nozzles: **[66 inches] [72 inches] <Insert dimension>**.
 7. Control: **[Thermostatic] [Pressure-balance]** mixing valve with hot- and cold-water operation.
 8. Control: Thermostatic mixing valve with individual, tempered-water supply and push-button operation.
 9. Shower-Arm, Flow-Control Fitting: **[Not required] [1.5 gpm] [2.0 gpm] [2.5 gpm]** for each shower head.
 10. EPA WaterSense: Required.
 11. Liquid Soap Dispenser: **[Not required] [Required]** for each shower head.
 12. Soap Dish: **[Not required] [Required]** for each shower head.
 13. Mounting: Floor flange.
 14. Supplies: **[NPS 3/4] [NPS 1]** copper tubing with shutoff valve from **[bottom] [top]**.
 15. Shroud: **[Not required] [Stainless steel of size to cover supplies and vent piping]**.
 16. Drain Fitting: **[NPS 3] [NPS 4]** outlet with NPS 2 vent, integral with base of column.
- B. Group Wall-Mounted Showers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Acorn Engineering Company.
 - b. Bradley Corporation.
 - c. Willoughby Industries.
 - d. Zurn Industries, LLC.
 2. Description: Stainless-steel, wall-mounted, surface-enclosure shower fixture with individual nozzles.
 3. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
 4. Metal Nominal Thickness: **[0.050 inch minimum] [0.063 inch]**.
 5. Number of Shower Nozzles: **[Two] [Three]**.
 6. Height to Nozzles: **[66 inches] [72 inches] <Insert dimension>**.
 7. Control: **[Thermostatic] [Pressure-balance]** valve with individual hot- and cold-water mixing-valve operation.
 8. Control: Thermostatic valve with individual, tempered-water supply and push-button operation.
 9. Flow-Control Fitting: **[Not required] [1.5 gpm] [2.0 gpm] [2.5 gpm]** for each shower head.
 10. EPA WaterSense: Required.
 11. Liquid Soap Dispenser: **[Not required] [Required]** for each shower head.
 12. Soap Dish: **[Not required] [Required]** for each shower head.
 13. Mounting: Wall bracket.
 14. Supplies: NPS 3/4 copper tubing with valves.

2.16 LAMINAR-FLOW, FAUCET-SPOUT OUTLETS

- A. NSF Standard: Comply with NSF 372 for faucet-spout-outlet materials that will be in contact with potable water.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. AM Conservation Group, Inc.
 2. Chronomite Laboratories, Inc.
 3. NEOPERL, Inc.
 4. T&S Brass and Bronze Works, Inc.

- C. Description: Chrome-plated-brass, faucet-spout outlet that produces non-aerating, laminar stream. Include external or internal thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

2.17 LAVATORY AND SINK SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.
- F. Risers:
 - 1. Lavatories: NPS 3/8Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces, ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser.
 - 2. Sinks: NPS 1/2Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces, ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser.

2.18 LAVATORY AND SINK WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 or NPS 1-1/2offset and straight tailpiece.
- C. Traps:
 - 1. Lavatories: NPS 1-1/2 by 1-1/4.
 - 2. Sinks: NPS 1-1/2.
 - 3. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inchthick brass tube to wall and chrome-plated, brass or steel wall flange.
 - 4. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch thick stainless-steel tube to wall; and stainless-steel wall flange.
- D. Continuous Waste:
 - 1. Size: NPS 1-1/2" or NPS 2".
 - 2. Material: Chrome-plated, 0.032-inchthick brass tube.

2.19 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.20 SUPPORTS

- A. Water Closet Carrier:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Zurn Industries, LLC.
 - 2. Standard: ASME A112.6.1M.
 - 3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.[**Include additional extension coupling, faceplate, and feet for installation in wide pipe space.**]

- B. Type I & II Urinal Carrier:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. WATTS.
 - e. Zurn Industries, LLC.
 - 2. Standard: ASME A112.6.1M.
- C. Type I & II Sink Carrier:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. WATTS.
 - e. Zurn Industries, LLC.
 - 2. Standard: ASME A112.6.1M.
- D. Type I, II & III Lavatory Carrier:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. WATTS.
 - e. Zurn Industries, LLC.
 - 2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls, floors and counters for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Water-Closet Installation:
 - 1. Install level and plumb according to roughing-in drawings.
 - 2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
 - 3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
- B. Water-Closet Support Installation:
 - 1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
 - 2. Use carrier supports with waste-fitting assembly and seal.
 - 3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
 - 4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
- C. Water-Closet Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
 3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
 4. Install actuators in locations that are easy for people with disabilities to reach.
- D. Install toilet seats on water closets.
- E. Urinal Installation:
1. Install urinals level and plumb according to roughing-in drawings.
 2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
 3. Install wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
 4. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.
 5. Install trap-seal liquid in waterless urinals.
- F. Urinal Support Installation:
1. Install supports, affixed to building substrate, for wall-hung urinals.
 2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
 3. Use carriers without waste fitting for urinals with tubular waste piping.
 4. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
- G. Urinal Flushometer-Valve Installation:
1. Install flushometer-valve water-supply fitting on each supply to each urinal.
 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
 3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
- H. Install lavatories, sinks and showers level and plumb according to roughing-in drawings.
- I. Install supports, affixed to building substrate, for wall-mounted lavatories and sinks.
- J. Install accessible wall-mounted lavatories and sinks at accessible mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
- K. Set floor-mounted sinks, shower receptors or shower basins in leveling bed of cement grout.
- L. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- M. Assemble shower components according to manufacturers' written instructions.
- N. Install water-supply piping with stop on each supply to each fixture faucet.
1. Exception: Use ball or gate valves if supply stops are not specified with fixture or integral with fixture. Comply with valve requirements specified in Section 220523 "General Duty Valves for Plumbing Piping."
 2. Install stops in locations where they can be easily reached for operation.
- O. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- P. Seal joints between fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- Q. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, risers, traps, soil, waste, and vent piping. Use size fittings required to match fixtures.



- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to fixtures, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install fresh batteries in all battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. After completing installation of fixtures, inspect and repair damaged finishes.
- B. Clean fixtures, faucets, flush valves and fittings with manufacturers' recommended cleaning methods and materials.
- C. Install protective covering for installed fixtures and fittings.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 40 00

**SECTION 22 45 00
EMERGENCY PLUMBING FIXTURES**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Emergency showers.
 - 2. Eyewash equipment.
 - 3. Eye/face wash equipment.
 - 4. Combination units.
 - 5. Supplemental equipment.
 - 6. Water-tempering equipment.

1.3 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.
- D. Tepid: Moderately warm.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
- B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushing-Fluid Solution: Separate lot and equal to at least 200 percent of amount of solution installed for each self-contained unit.

1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- C. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

- D. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

2.1 EMERGENCY SHOWERS

- A. Freestanding, Plumbed Emergency Showers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 2. Capacity: Not less than 20 gpm for at least 15 minutes.
 3. Supply Piping: NPS 1 or NPS 1-1/4, galvanized steel, chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 4. Control-Valve Actuator: Pull rod or Foot treadle.
 5. Shower Head: 8-inch minimum diameter, chrome-plated brass, stainless steel, or plastic.
 6. Mounting: Pedestal.
- B. Off-Floor, Plumbed Emergency Showers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 2. Capacity: Not less than 20 gpm for at least 15 minutes.
 3. Supply Piping: NPS 1, galvanized steel, chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 4. Control-Valve Actuator: Pull rod.
 5. Shower Head: 8-inch minimum diameter, chrome-plated brass, stainless steel, or plastic.
 6. Mounting: Horizontal from wall or Vertical from ceiling and supported from piping.

2.2 EYEWASH EQUIPMENT

- A. Standard, Freestanding, Plumbed Eyewash Units:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 2. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 4. Control-Valve Actuator: Paddle or Treadle.
 5. Spray-Head Assembly: Two receptor-mounted spray heads.
 6. Receptor: Chrome-plated brass or stainless-steel or Plastic bowl.
 7. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2. Include galvanized-steel indirect connection to drainage system.
 8. Mounting: Pedestal.
- B. Accessible, Freestanding, Plumbed Eyewash Units:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:



- a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Encon Safety Products.
 - d. Guardian Equipment Co.
 - e. WaterSaver Faucet Co.
 2. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 4. Control-Valve Actuator: Paddle.
 5. Spray-Head Assembly: Two receptor-mounted spray heads.
 6. Receptor: Chrome-plated brass or stainless-steel bowl.
 7. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2. Include galvanized-steel indirect connection to drainage system.
 8. Mounting: Offset pedestal.
 9. Special Construction: Comply with ICC/ANSI A117.1.
- C. Standard, Wall-Mounted, Plumbed Eyewash Units:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 2. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 4. Control-Valve Actuator: Paddle.
 5. Spray-Head Assembly: Two receptor-mounted spray heads.
 6. Receptor: Chrome-plated brass or stainless-steel bowl.
 7. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.
 8. Mounting: Wall bracket.
- D. Accessible, Wall-Mounted, Plumbed Eyewash Units:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 2. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 4. Control-Valve Actuator: Paddle.
 5. Spray-Head Assembly: Two receptor-mounted spray heads.
 6. Receptor: Chrome-plated brass or stainless-steel bowl.
 7. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.
 8. Mounting: Wall bracket.
 9. Special Construction: Comply with ICC/ANSI A117.1.
- E. Sink, Fixed-Position, Plumbed Eyewash Unit:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.

- b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 2. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 4. Control-Valve Actuator: Paddle.
 5. Spray-Head Assembly: Two spray heads positioned over sink.
 6. Mounting: Attached to sink receptor.
- F. Sink, Swivel-Type, Plumbed Eyewash Unit:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 2. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 4. Control-Valve Actuator: Movement of spray-head assembly to position over sink.
 5. Spray-Head Assembly: Two spray heads with offset piping.
 6. Mounting: Deck next to sink.
- G. Portable, Self-Contained Eyewash Units:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradley Corporation.
 - b. Guardian Equipment Co.
 - c. Haws Corporation.
 - d. WaterSaver Faucet Co.
 2. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 3. Pressure Tank: 10 gal., stainless steel, cylindrical, with pressure gage, and suitable for on-floor installation.
 4. Flushing Fluid: Medically acceptable solution manufactured and labeled according to applicable regulations.
 5. Spray-Head Assembly: Chrome-plated copper alloy or stainless-steel piping with flow regulator; paddle-actuated, stay-open control valve; and two spray heads mounted on tank.
 6. Drench Hose: Hand-held spray head with squeeze-handle actuation and hose attached to tank.
- H. Standard, Self-Contained Eyewash Units:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradley Corporation.
 - b. Guardian Equipment Co.
 - c. Haws Corporation.
 - d. WaterSaver Faucet Co.
 2. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 3. Gravity Tank: 14 gal. minimum, plastic, and suitable for shelf mounting.
 4. Flushing Fluid: Medically acceptable solution manufactured and labeled according to applicable regulations.
 5. Actuator: Pull-down front panel.
 6. Spray Heads: Protected, two mounted on tank.

2.3 EYE/FACE WASH EQUIPMENT

- A. Standard, Freestanding, Plumbed, Eye/Face Wash Units:



1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 2. Capacity: Not less than 3.0 gpm for at least 15 minutes.
 3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 4. Control-Valve Actuator: Paddle or Treadle.
 5. Spray-Head Assembly: Two or four receptor-mounted spray heads.
 6. Receptor: Chrome-plated brass or stainless-steel bowl.
 7. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2. Include galvanized-steel indirect connection to drainage system.
 8. Mounting: Pedestal.
- B. Accessible, Freestanding, Plumbed, Eye/Face Wash Units:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. WaterSaver Faucet Co.
 2. Capacity: Not less than 3 gpm for at least 15 minutes.
 3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 4. Control-Valve Actuator: Paddle.
 5. Spray-Head Assembly: Two or four receptor-mounted spray heads.
 6. Receptor: Chrome-plated brass or stainless-steel bowl.
 7. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2. Include galvanized-steel indirect connection to drainage system.
 8. Mounting: Offset pedestal.
 9. Special Construction: Comply with ICC/ANSI A117.1.
- C. Standard, Wall-Mounted, Plumbed, Eye/Face Wash Units:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 2. Capacity: Not less than 3.0 gpm for at least 15 minutes.
 3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 4. Control-Valve Actuator: Paddle.
 5. Spray-Head Assembly: Two or four receptor-mounted spray heads.
 6. Receptor: Chrome-plated brass or stainless-steel bowl.
 7. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.
 8. Mounting: Wall bracket.
- D. Accessible, Wall-Mounted, Plumbed, Eye/Face Wash Units:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradley Corporation.



- b. Guardian Equipment Co.
 - c. Haws Corporation.
 - d. WaterSaver Faucet Co.
 - 2. Capacity: Not less than 3.0 gpm for at least 15 minutes.
 - 3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 - 4. Control-Valve Actuator: Paddle.
 - 5. Spray-Head Assembly: Two or four receptor-mounted spray heads.
 - 6. Receptor: Chrome-plated brass or stainless-steel bowl.
 - 7. Mounting: Wall bracket.
 - 8. Special Construction: Comply with ICC/ANSI A117.1.
- E. Sink, Fixed-Position, Plumbed, Eye/Face Wash Units:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 - 2. Capacity: Not less than 3 gpm for at least 15 minutes.
 - 3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 - 4. Control-Valve Actuator: Paddle.
 - 5. Spray-Head Assembly: Two or four spray heads positioned over sink.
 - 6. Receptor: Chrome-plated brass or stainless-steel bowl.
 - 7. Mounting: Attached to sink receptor.

2.4 COMBINATION UNITS

- A. Standard, Plumbed Emergency Shower with Eyewash Combination Units:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 - 2. Piping:
 - a. Material: Galvanized steel, Chrome-plated brass or stainless steel.
 - b. Unit Supply: NPS 1-1/4 or NPS 1-1/2 minimum.
 - c. Unit Drain: Outlet at back or side near bottom.
 - 3. Shower:
 - a. Capacity: Not less than 20 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Pull rod or Treadle.
 - d. Shower Head: 8-inch minimum diameter, chrome-plated brass or stainless steel.
 - e. Mounting: Pedestal.
 - 4. Eyewash Unit:
 - a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two receptor-mounted spray heads.
 - e. Receptor: Chrome-plated brass or stainless-steel bowl.
 - f. Mounting: Attached shower pedestal.
 - g. Drench-Hose Option: May be provided instead of eyewash unit.

- 1) Capacity: Not less than 0.4 gpm for at least 15 minutes.
 - 2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
 - 3) Mounting: Bracket on shower pedestal.
- B. Accessible, Plumbed Emergency Shower with Eyewash Combination Units:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 2. Piping:
 - a. Material: Galvanized steel, Chrome-plated brass or stainless steel.
 - b. Unit Supply: NPS 1-1/4 or NPS 1-1/2 minimum.
 - c. Unit Drain: Outlet at back or side near bottom.
 3. Shower:
 - a. Capacity: Not less than 20 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Pull rod.
 - d. Shower Head: 8-inch minimum diameter, chrome-plated brass or stainless steel.
 - e. Mounting: Pedestal.
 4. Eyewash Unit:
 - a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two receptor-mounted spray heads.
 - e. Receptor: Chrome-plated brass or stainless-steel bowl.
 - f. Mounting: Attached shower pedestal.
 - g. Drench-Hose Option: May be provided instead of eyewash unit.
 - 1) Capacity: Not less than 0.4 gpm for at least 15 minutes.
 - 2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
 - 3) Mounting: Bracket on shower pedestal.
- C. Standard, Plumbed Emergency Shower with Eye/Face Wash Combination Units:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 2. Piping:
 - a. Material: Galvanized steel, Chrome-plated brass or stainless steel.
 - b. Unit Supply: NPS 1-1/4 or NPS 1-1/2 minimum.
 - c. Unit Drain: Outlet at back or side near bottom.
 3. Shower:
 - a. Capacity: Not less than 20 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Pull rod or Treadle.
 - d. Shower Head: 8-inch minimum diameter, chrome-plated brass or stainless steel.
 - e. Mounting: Pedestal.
 4. Eye/Face Wash Unit:
 - a. Capacity: Not less than 3 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.

- c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two or four receptor-mounted spray heads.
 - e. Receptor: Chrome-plated brass or stainless-steel bowl.
 - f. Mounting: Attached shower pedestal.
 - g. Drench-Hose Option: May be provided instead of eye/face wash unit.
 - 1) Capacity: Not less than 3 gpm for at least 15 minutes.
 - 2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
 - 3) Mounting: Bracket on shower pedestal.
- D. Accessible, Plumbed Emergency Shower with Eye/Face Wash Combination Units:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 - 2. Piping:
 - a. Material: Galvanized steel, Chrome-plated brass or stainless steel.
 - b. Unit Supply: NPS 1-1/4 or NPS 1-1/2 minimum.
 - c. Unit Drain: Outlet at back or side near bottom.
 - 3. Shower:
 - a. Capacity: Not less than 20 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Pull rod.
 - d. Shower Head: 8-inch minimum diameter, chrome-plated brass or stainless steel.
 - e. Mounting: Pedestal.
 - 4. Eye/Face Wash Unit:
 - a. Capacity: Not less than 3 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two or four receptor-mounted spray heads.
 - e. Receptor: Chrome-plated brass or stainless-steel bowl.
 - f. Mounting: Attached to shower pedestal.
 - g. Drench-Hose Option: May be provided instead of eye/face wash unit.
 - 1) Capacity: Not less than 3 gpm for at least 15 minutes.
 - 2) Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
 - 3) Mounting: Bracket on shower pedestal.

2.5 SUPPLEMENTAL EQUIPMENT

- A. Self-Contained, Personal Eyewash Units:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradley Corporation.
 - b. Guardian Equipment Co.
 - c. Haws Corporation.
 - d. Speakman Company.
 - 2. Capacity: Not less than 0.4 gpm.
 - 3. Pressure Tank: 5 gal., stainless steel, cylindrical, with pressure gage and base suitable for on-floor installation.
 - 4. Flushing Fluid: Medically acceptable solution manufactured and labeled according to applicable regulations.
 - 5. Spray-Head Assembly: Chrome-plated copper alloy or stainless-steel piping with flow regulator; paddle-actuated, stay-open control valve; and two spray heads mounted on tank.

- B. Deck-Mounted, Plumbed Drench Hoses:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 - 2. Capacity: Not less than 0.4 gpm.
 - 3. Supply Fitting: NPS 1/2 brass with flow regulator.
 - 4. Drench Hose: Hand-held spray head with squeeze-handle actuation and hose.
 - 5. Mounting: In hole in deck.
- C. Wall-Mounted, Plumbed Drench Hoses:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 - 2. Capacity: Not less than 3.0 gpm for at least 15 minutes.
 - 3. Supply Fitting: NPS 1/2 brass with flow regulator.
 - 4. Drench Hose: Hand-held spray head with squeeze-handle actuation and hose.
 - 5. Mounting: Wall bracket.

2.6 WATER-TEMPERING EQUIPMENT

- A. Hot- and Cold-Water, Water-Tempering Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Haws Corporation.
 - 2. Description: Factory-fabricated equipment with thermostatic mixing valve.
 - a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
 - b. Supply Connections: For hot and cold water.

2.7 SOURCE QUALITY CONTROL

- A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.

- D. Install shutoff valves in water-supply piping to fixtures. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 22 05 23 "General Duty Valves for Plumbing Piping."
 - 1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
 - 2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
- E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 22 11 16 "Domestic Water Piping."
- F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- H. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- J. Fill self-contained fixtures with flushing fluid.

3.3 CONNECTIONS

- A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 22 11 16 "Domestic Water Piping."
- B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 22 11 16 "Domestic Water Piping."
- C. Connect cold water and electrical power to electric heating water-tempering equipment. Comply with requirements for cold-water piping specified in Section 22 11 16 "Domestic Water Piping."
- D. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- E. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.
- F. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:



1. Perform each visual and mechanical inspection.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
- 3.6 ADJUSTING**
- A. Adjust or replace fixture flow regulators for proper flow.
 - B. Adjust equipment temperature settings.

END OF SECTION 22 45 00

**SECTION 22 47 13
DRINKING FOUNTAINS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes drinking fountains and related components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of drinking fountain.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include operating characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For drinking fountains to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 DRINKING FOUNTAINS

- A. Exterior Drinking Fountains: Concrete, Painted cast iron or steel, pedestal.
 - 1. Concrete Drinking Fountains:
 - a. Manufacturers: Subject to compliance with requirements, provide products by the following to match existing campus standards:
 - 1) Elkay Manufacturing Co.
 - 2. Cast-Iron or Steel Drinking Fountains:
 - a. Manufacturers: Subject to compliance with requirements, provide products by the following to match existing campus standards:
 - 1) Elkay Manufacturing Co.
 - 3. Standards: Comply with ICC A117.1 and NSF 61 Annex G.
 - 4. Pedestal: Rectangular or Round, with offset to receptor or with side receptor(s).
 - 5. Receptor(s):
 - a. Number: One or Two or per Architectural drawings.
 - b. Material: Chrome-plated brass or stainless steel.
 - c. Shape: Rectangular, Round or Rounded front.
 - d. Bubbler: One for each receptor, with adjustable stream regulator.
 - e. Drain: Grid type with NPS 1-1/4 tailpiece.
 - 6. Maximum water flow: 0.15 or 0.5 gpm.
 - 7. Controls: Push bar or Push button.
 - 8. Access to Internal Components: Panel in pedestal.
 - 9. Supply Piping: NPS 3/8NPS 1/2 with shutoff valve.
 - 10. Drain Piping: NPS 1-1/4NPS 1-1/2 minimum trap and waste.
- B. Drinking Fountains: Stainless steel or Vitreous china, wall mounted.
 - 1. Stainless-Steel Drinking Fountains:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co; model LZSTL8WSSP or a comparable product by one of the following:
 - 1) Filtrine Manufacturing Company.
 - 2) Haws Corporation.
 - 3) Murdock Manufacturing; A Member of Morris Group International.



2. Standards:
 - a. Comply with ASME A112.19.3/CSA B45.4 and ASME A112.19.2/CSA B45.1.
 - b. Comply with NSF 61 Annex G.
 3. Type Receptor: With back or on horizontal support.
 4. Receptor Shape: Rectangular or Round.
 5. Back Panel: Stainless-steel wall plate behind drinking fountain.
 6. Bubblers: One or Two, with adjustable stream regulator, located on deck.
 7. Maximum water flow: 0.15 or 0.5 gpm.
 8. Control: Push button or Push bar.
 9. Drain: Grid type with NPS 1-1/4 tailpiece.
 10. Supply: NPS 3/8 with shutoff valve.
 11. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 chrome-plated brass P-trap and waste.
 12. Support: Type I water cooler carrier or Type II water cooler carrier.
 13. Drinking Fountain Mounting Height: Standard or Accessible or per Architectural plans.
- C. Drinking Fountains: Stainless steel, recessed.
1. Manufacturers: Subject to compliance with requirements, provide products by the following to match existing campus standards:
 - a. Elkay Manufacturing Co.
 2. Standard: Comply with NSF 61 Annex G.
 3. Receptor Shape: Concave with flush wall flange.
 4. Bubbler: One, with adjustable stream regulator, located on deck.
 5. Control: Push button or Push bar.
 6. Drain: Grid with NPS 1-1/4 minimum horizontal waste and trap, complying with ASME A112.18.2/CSA B125.2.
 7. Supply: NPS 3/8 with shutoff valve.
 8. Support: Mounting frame or brackets for attaching to substrate.

2.2 SUPPORTS

- A. Type I Water Cooler Carrier:
1. Manufacturers: Subject to compliance with requirements, provide products by the following to match existing campus standards:
 - a. Elkay Manufacturing Co
 2. Standard: ASME A112.6.1M.
- B. Type II Water Cooler Carrier:
1. Manufacturers: S Subject to compliance with requirements, provide products by the following to match existing campus standards:
 - a. Elkay Manufacturing Co.
 2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Set pedestal drinking fountains on floor.
- C. Install recessed drinking fountains secured to wood blocking in wall construction.



- D. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 22 05 23 "General Duty Valves for Plumbing Piping."
- F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Install ball or gate shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 22 05 23 "General Duty Valves for Plumbing Piping."
- D. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.

3.5 CLEANING

- A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 47 13

**SECTION 23 00 00
GENERAL MECHANICAL REQUIREMENTS**

PART 1 - GENERAL

1.1 SCOPE

- A. Basic mechanical requirements specifically applicable to Division 23 and 33 Sections.
- B. Work includes but is not necessarily limited to the following:
 - 1. Labor, materials, services, equipment, and appliances required for completion of tasks as indicated on drawing or in specification or as inherently necessary to prepare spaces and systems for new installations as follows:
 - a. Heating, ventilating and air conditioning systems and equipment
 - b. Testing, adjusting and balancing
 - 2. **The use of variable refrigerant flow (VRF/VRV) systems is not acceptable.**

1.2 DRAWINGS AND SPECIFICATIONS

- A. Drawings accompanying these Specifications show intent of Work to be done. Specifications shall identify quality and grade of installation and where equipment and hardware is not particularly specified, Contractor shall provide submittals for all products and install them per manufacturers' recommendations, and in a first class manner.
- B. Examine Drawings and Specifications for elements in connection with this Work; determine existing and new general construction conditions and be familiar with all limitations caused by such conditions.
- C. Plans are intended to show general arrangement and extent of Work contemplated. Exact location and arrangement of parts shall be determined after the Owner has reviewed equipment, as Work progresses, to conform in best possible manner with surroundings, and as directed by the Owner's Representative.
- D. Contract Documents are in part diagrammatic and intended to show the scope and general arrangement of the Work under this Contract. The Contractor shall follow these drawings in laying out the equipment, piping and ductwork. Drawings are not intended to be scaled for roughing in measurements or to serve as shop drawings. Where job conditions require minor changes or adjustments in the indicated locations or arrangement of the Work, such changes shall be made without change in the Contract amount.
- E. Follow dimensions without regard to scale. Where no figures or notations are given, the Plans shall be followed.

1.3 UTILITIES

- A. Location and sizes of electrical, mechanical and plumbing service facilities are shown in accordance with data secured from existing record drawings and site observations. Data shown are offered as an estimating guide without guarantee of accuracy. Check and verify all data given, and verify exact location of all utility services pertaining to Work prior to excavation or performing Work.

1.4 APPLICABLE REFERENCE STANDARDS, CODES AND REGULATIONS

- A. Meet requirements of all state codes having jurisdiction.
- B. State of California Code of Regulations:
 - 1. Title 8, Industrial Relations
 - 2. Title 19, State Fire Marshal Regulations
 - 3. Current California Building Code (CBC), Title 24, Part 2
 - 4. Current California Electrical Code, Title 24, Part 3
 - 5. Current California Mechanical Code, Title 24, Part 4
 - 6. Current California Plumbing Code, Title 24, Part 5
 - 7. Current California Energy Code, Title 24, Part 6
 - 8. Current California Fire Code, Title 24, Part 9
 - 9. Current California Standards Code, Title 24, Part 12



C. Additional Referenced Standards:

1. AABC – Associated Air Balance Council
2. AMCA – Air Moving and Conditioning Association
3. ARI – Air-Conditioning and Refrigeration Institute
4. ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers
5. ASME – American Society of Mechanical Engineers
6. ASTM – American Society for Testing and Materials
7. NEMA – National Electrical Manufacturer’s Association
8. NFPA – National Fire Protection Association Standards
9. PDI – Plumbing and Drainage Institute
10. UL – Underwriters Laboratories

D. Codes and ordinances having jurisdiction over Work are minimum requirements; but, if Contract Documents indicate requirements, which are in excess of those minimum requirements, then requirements of the Contract Documents shall be followed. Should there be any conflicts between Contract Documents or codes or any ordinances having jurisdiction, report these to the Owner’s Representative.

E. Obtain permits, and request inspections from authority having jurisdiction.

1.5 PROJECT AND SITE CONDITIONS

A. The arrangement of and connection to equipment shown on the Drawings is based upon information available and is not intended to show exact dimensions peculiar to a specific manufacturer. The Drawings are, in part, diagrammatic and some features of the illustrated equipment installations may require revision to meet actual equipment installation requirements. Structural supports, housekeeping pads, piping connections and adjacent equipment may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions or alterations.

B. Examine all Drawings and Specifications to be fully cognizant of all work required under this Division.

C. Examine site related work and surfaces before starting work of any Section.

D. Install Work in locations shown on approved Drawings, unless prevented by Project conditions.

E. Prepare shop drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission from the Owner’s Representative before proceeding.

1.6 COOPERATION WITH WORK UNDER OTHER DIVISIONS

A. Cooperate with other trades to facilitate general progress of Work. Allow all other trades every reasonable opportunity for installation of their work.

B. Work under this Division shall follow general building construction closely. Set pipe sleeves and inserts and verify that openings for chases and pipes are provided.

C. Work with other trades in determining exact location of outlets, pipes, and pieces of equipment to avoid interference with lines required to maintain proper installation of Work.

D. Make such progress in the Work to not delay work of other trades.

E. Mechanical Work shall have precedence over the other in the following sequence:

1. Soil and waste piping
2. Hydronic piping
3. Ductwork
4. Domestic water piping
5. Fire sprinkler piping



1.7 DISCREPANCIES

- A. The Contractor shall check all Drawings furnished him immediately upon their receipt and shall promptly notify the Owner's Representative of any discrepancies. Figures marked on Drawings shall in general be followed in preference to scale measurements. Piping and instrumentation diagrams shall in general govern floor plans and sections. Large-scale drawings shall in general govern small-scale drawings.
- B. Where requirements between Drawings and Specifications conflict, the more restrictive provisions shall apply.
- C. If any part of the Specifications or Drawings appears unclear or contradictory, apply to Owner's Representative for interpretation and decision as early as possible, including during bidding period. Do not proceed with such work without Owner Representatives decision. Beginning work of any Section constitutes acceptance of conditions.

1.8 CHANGES

- A. The Contractor shall be responsible to make and obtain approval from the Owner's Representative for all necessary adjustments in piping and equipment layouts as required to accommodate the relocations of equipment and/or devices, which are affected by any approved authorized changes or Product substitutions. All changes shall be clearly indicated on the "Record" drawings.

1.9 SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular specification section.
- B. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
- C. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- D. Note that prior to acceptance of submittals for review, a submittal schedule shall be submitted to the Owner's Representative.
- E. Submit all Division 23 shop drawings and product data grouped and referenced by the specification technical section number in one complete submittal package.
- F. Shop Drawings:
 - 1. Include installation details of equipment indicating proposed location, layout and arrangement, accessories, piping, and other items that must be shown to assure a coordinated installation.
 - 2. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
 - 3. If equipment is rejected, revise drawings to show acceptable equipment and resubmit.
 - 4. Whenever more than one (1) manufacturer's product is specified, the first named product is the basis of design used in the Drawings and the use of alternate-named manufacturer's products or substitutes may require modifications to the design.
 - 5. The Contractor shall be responsible for all equipment ordered and/or installed prior to receipt of shop drawings returned from the Owner's Representative bearing the Owner's Representative stamp of "Reviewed". All corrections or modifications to the equipment as noted on the shop drawings shall be performed and equipment removed from the job site at the request of the Owner's Representative without additional compensation.
 - 6. Manufacturer's Data: For each manufactured item, provide current manufacturer's descriptive literature of cataloged products, certified equipment drawings, diagrams, performance and characteristic curves if applicable, and catalog cuts.
 - 7. Standard Compliance: When materials or equipment provided by the Contractor must conform to the standards of organizations such as American National Standards Institute (ANSI) or American Water Works Association (AWWA), submit proof of such conformance to the Owner Representative for approval. If an organization uses a label or listing to indicate compliance with a particular



standard, the label or listing will be acceptable evidence, unless otherwise specified. In lieu of the label or listing, submit a certificate from an independent testing organization, which is competent to perform acceptance testing and is approved by the Owner Representative. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard.

8. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in individual sections shall be submitted for approval.
9. Certificates of Compliance or Conformance: Submit manufacturer's certifications as required on products, materials, finish, and equipment indicated in the technical sections. Certifications shall be documents prepared specifically for this Contract. Pre-printed certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; or "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance or conformance.

1.10 PROJECT RECORD DOCUMENTS

- A. All changes, deviations and information recorded on the "Project Record Drawings" set during Construction shall be redrafted onto the latest version of AutoCAD or Revit, where applicable.
- B. Submit completed shop drawings to the Owner prior to completion in AutoCAD format.
- C. Contractor hand marked or drafted redlined "Project Record Drawings" will not be accepted.

1.11 OPERATING INSTRUCTIONS

- A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel.

1.12 MANUFACTURER'S RECOMMENDATIONS

- A. Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.

1.13 DELIVERY AND STORAGE

- A. Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B P, Appendix I, titled "Equipment Storage and Maintenance During Construction." Replace damaged or defective items with new items.

1.14 GUARANTEE

- A. Except as may be specified under other sections in the Specifications, guarantee all equipment furnished under the Specifications for a period of one year from date of project acceptance against defective workmanship and material and improper installation. Upon notification of failure, correct deficiency immediately and without cost to the Owner.
- B. Standard warranty of manufacturer shall apply for replacement of parts after expiration of the above period. Manufacturer shall furnish replacement parts to the Owner for their service agency as directed.

1.15 COMMISSIONING

- A. Division 23 will be responsible to carry out the commissioning requirements.
- B. Management:
 1. The Commissioning Agent (CA) is hired directly by the Owner.



2. The CA directs and coordinates the commissioning activities and the reports to the Owner's Representative.
 3. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.
 4. All contractors shall include the cost of commissioning in the contract price. The contractors should be prepared to provide commissioning assistance and follow through until all the commissioned systems have been signed off by the commissioning provider and the Owner Representative.
 5. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
- C. Commissioning requires the participation of Division 23 Mechanical Contractor to work to ensure that all systems are operating in a manner consistent with the Design Intent.
- D. The mechanical contractor is responsible for assisting the commissioning agent throughout the entire commissioning process. The work is not complete until the commissioning agent and the Owner Representative has signed off on the commissioned systems.

1.16 COMMISSIONING RESPONSIBILITIES

- A. Mechanical Contractor: The commissioning responsibilities applicable to the mechanical contractor are as follows (all references apply to commissioned equipment only):
1. All contractors shall include the cost of commissioning in the contract price. The contractors should be prepared to provide commissioning assistance and follow through until all the commissioned systems have been signed off by the commissioning provider and the Owner Representative.
 2. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
 3. General Contractor shall attend a commissioning kickoff meeting and other meetings necessary to facilitate the commissioning process.
 4. General Contractor shall provide the Commissioning Provider with normal cut sheets and shop drawing submittals of commissioned equipment.
 5. General Contractor shall provide additional requested documentation, prior to normal O&M manual submittals, to the Commissioning Provider for development of start-up and functional testing procedures.
 - a. Typically, this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Provider.
 - b. The Commissioning Provider may request further documentation necessary for the commissioning process.
 6. General Contractor shall provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the Commissioning Provider for review.
 7. Sub-Contractors and design engineers shall assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 8. General Contractor shall provide limited assistance to the Commissioning Provider in preparing the specific functional performance test procedures. Sub-Contractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
 9. General Contractor shall develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the pre-functional checklists from the Commissioning Provider for all commissioned equipment. Submit to Commissioning Provider for review prior to startup.
 10. During the startup and initial checkout process, execute the mechanical related portions of the pre-functional checklists for all commissioned equipment.



11. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the Commissioning Provider.
 12. Address current Engineer of Record punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.
 13. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.
 14. Provide skilled technicians to perform functional performance testing under the direction of the Commissioning Provider. Assist the Commissioning Provider in interpreting the monitoring data, as necessary.
 15. Correct deficiencies (differences between specified and observed performance) as interpreted by the Commissioning Provider, Owner's Representative and Engineer of Record and retest the equipment.
 16. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
 17. During construction, maintain as-built redline drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. Update after completion of commissioning.
 18. Provide training of the Owner Representative's operating staff using expert qualified personnel, as specified.
 19. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
 20. Execute any deferred functional performance testing, witnessed by the Commissioning Provider, according to the specifications.
 21. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
- B. Mechanical Contractor. The responsibilities of the HVAC mechanical contractor, during construction and acceptance phases in addition to those listed in (A) are:
1. Provide startup for all HVAC equipment, except for the building automation control system.
 2. Assist and cooperate with the TAB contractor and Commissioning Provider by:
 - a. Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
 - b. Including cost of sheaves and belts that may be required by TAB.
 - c. Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Provide an approved plug.
 - d. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
 3. Install a P/T plug at each water sensor, which is an input point to the control system.
 4. List and clearly identify on the as-built drawings the locations of all air-flow stations.
 5. Prepare a preliminary schedule for pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the Commissioning Provider. Update the schedule as appropriate.
 6. Notify the Owner's Representative when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the Owner's Representative or Commissioning Provider, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the Commissioning Provider has the scheduling information needed to efficiently execute the commissioning process.

PART 2 - PRODUCTS

- A. Not Applicable.



PART 3 - EXECUTION

3.1 GENERAL

- A. Obtain and pay for all permits and inspections, including any independent testing required to verify standard compliance, and deliver certificates for same to the Owner's Representative.

3.2 WORK RESPONSIBILITIES

- A. The drawings indicate diagrammatically the desired locations or arrangement of piping, equipment, etc., and are to be followed as closely as possible. Proper judgment must be exercised in executing the work to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference with structural conditions.
- B. The Contractor is responsible for the correct placing of Work and the proper location and connection of Work in relation to the work of other trades. Advise appropriate trade as to locations of access panels.
- C. In the event changes in the indicated locations or arrangements are necessary, due to developed conditions in the building construction or rearrangement of furnishings or equipment, such changes shall be made without extra cost, providing the change is ordered before the ductwork, piping, etc. and work directly connected to same is installed and no extra materials are required.
- D. Where equipment is furnished by others, verify dimensions and the correct locations of this equipment before proceeding with the roughing-in of connections.
- E. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any work, carefully check and verify all dimensions, sizes, etc. with the drawings to see that the equipment will fit into the spaces provided without violation of applicable codes.
- F. Should any changes to the Work indicated on the Drawings or described in the Specifications be necessary in order to comply with the above requirements, notify the Owner immediately and cease work on all parts of the contract, which are affected until approval for any required modifications to the construction has been obtained from the Owner.
- G. Be responsible for any cooperative work, which must be altered due to lack of proper supervision or failure to make proper provisions in time. Such changes shall be under direction of the Owner and shall be made to his satisfaction. Perform all Work with competent and skilled personnel.
- H. All work, including aesthetic as well as mechanical aspects of the Work, shall be of the highest quality consistent with the best practices of the trade.
- I. Replace or repair, without additional compensation, any Work, which, in the opinion of the Owner, does not comply with these requirements.

3.3 PAINTING

- A. Refer to Division 09 for additional requirements.
- B. Factory Applied:
 - 1. Mechanical equipment shall have factory-applied painting systems, which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.20.
 - 2. Refer to individual sections of this Division for more stringent requirements.
- C. Field Applied:
 - 1. Paint all mechanical equipment as required to touch up, to match finish on other equipment in adjacent spaces or to meet safety criteria.
 - 2. Paint all exposed, uninsulated mechanical piping, valves, supports, hangers and appurtenances. Provide minimum 5 mils dry film thickness.
 - 3. Paint ductwork flat black that are visible behind air outlets and inlets.
 - 4. Paint all exposed and rooftop ductwork, roof mounted mechanical equipment, ductwork supports, hangers and appurtenances.
 - 5. Paint shall be a high performance polyurethane enamel coating system.



- a. Acceptable paint manufacturers include Ameron, Tnemec or engineer approved equal.
- b. Acceptable primer manufacturers include Ameron Amersfield VOC, Tnemec's Series 1075 (1074) Endura-Shield, semi-gloss (gloss) sheen or equal.
- c. Provide minimum 5 mils dry film thickness.

3.4 COMMISSIONING TRAINING OF OWNER'S REPRESENTATIVE PERSONNEL

- A. The General Contractor shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed.
- B. The Commissioning Provider shall be responsible for reviewing the content and adequacy of the training of Owner's Representative personnel for commissioned equipment.
- C. Mechanical Contractor. The mechanical contractor shall have the following training responsibilities:
 1. Provide the Commissioning Provider and A/E with a training plan at least two weeks before the planned training.
 2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment.
 3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
 4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
 5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
 6. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
 7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
 8. Training shall include:
 - a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
 - c. Discussion of relevant health and safety issues and concerns.
 - d. Discussion of warranties and guarantees.
 - e. Common troubleshooting problems and solutions.
 - f. Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
 - g. Discussion of any peculiarities of equipment installation or operation.
 - h. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
 9. Hands-on training shall include start-up, operation in all modes possible, including manual, shutdown and any emergency procedures and preventative maintenance for all pieces of equipment.
 10. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.



11. Training shall occur after functional testing is complete, unless approved otherwise by the Owner's Representative.

3.5 DUCT DISTRIBUTION

- A. Provide adjustable diffusers in smaller rooms.
- B. Supply air diffusers should not include perforated face.
- C. Provide egg crate style return diffusers.

3.6 LABELING AND DISTRIBUTION

- A. Identification: Text shall be no less than 12pt Black Arial on White Background.
- B. Placement: Labels shall be located at each register.

END OF SECTION 23 00 00



**SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC**

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Escutcheons.
 - 4. Equipment installation requirements common to equipment sections.
 - 5. Concrete bases.
 - 6. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 SUBMITTALS

- A. Welding certificates.
- B. Product Information for approval before purchase
- C. Operation and Maintenance Manuals

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.



2.2 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
- C. Pipe Flange Nuts and Bolts: Provide 304 stainless steel bolts, washers and nuts for mechanical rooms, underground piping and in humid areas.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.

2.3 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150 psig minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 150-psig minimum working pressure at 225 deg F.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 150-psig minimum working pressure at 225 deg F.

2.4 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.

PART 3 - EXECUTION

3.1 NOT APPLICABLE

END OF SECTION 23 05 00



**SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers:



1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

- A. Motor shall be an electronic commutation (EC) motor specifically designed for HVAC applications. AC induction type motors are not acceptable.
- B. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase.
- C. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown).
- D. Motor shall be a minimum of 85% efficient at all speeds.

PART 3 - EXECUTION

3.1 NOT APPLICABLE

END OF SECTION 23 05 13



**SECTION 23 05 14
VARIABLE FREQUENCY DRIVES**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Electrical General Requirements are part of this section and apply to this section as full as if repeated herein.
- B. Mechanical General Requirements, specification sections for Pumps, Electrical Motors, Air Handling Units, Fans, Energy Management System.

1.2 SCOPE

- A. Furnish labor and related materials, appliances, tools and equipment necessary for and incident to performing all operations in connection with furnishing, delivery, installation, and start up of Variable Frequency Drive.

1.3 QUALITY ASSURANCE AND STANDARDS

- A. The latest revision of the standards listed below form an integral part of this specification:
- B. American National Standard Institute (ANSI).
 - 1. Institute of Electrical and Electronic Engineers, Inc. (IEEE).
 - 2. National Electrical Manufacturer's Association (NEMA)
 - 3. National Fire Protection Association (NFPA)
 - 4. State of California Electrical Code (CEC).
 - 5. Underwriters Laboratories (UL)
- C. Manufacturer:
 - 1. Shall not have less than ten (10) years of experience in the manufacture of variable frequency drives similar to the type and size specified on this project.
 - 2. Shall be ISO-9002 certified.
 - 3. Manufacturer shall have nationwide technical support organization available 24 hours a day from a toll-free telephone number. Capabilities shall include factory coordinated start-up service and on-site training of customer personnel.
 - 4. Shall have a local service facility located within (50) miles radius of the project site and be able to provide field service with twenty (24) hours.

1.4 SUBMITTALS

- A. Technical cut-sheets, product data on adjustable frequency controllers, relays, pilot devices and switching and over-current protective devices.
- B. Factory Test Reports.
- C. Manufacturer's installation and operating instructions.
- D. Start-up service report.

1.5 MANUFACTURERS:

- A. ABB, Danfoss, or Yaskawa.

1.6 WARRANTY

- A. The drive manufacturer shall guarantee the operation of the drive against failure due to defects a minimum period of 24 months from the date of acceptance by Owner. Warranty shall cover all labor and parts required to repair/replace on site.



PART 2 - PRODUCTS

2.1 GENERAL:

- A. The alternating current variable speed drive shall include the microprocessor based variable controller, the required signal logic and control. The drive component specified including the variable frequency controller and its associated microprocessor control system shall be of the same manufacture. Coordinate with pump, cooling tower, fan or air handling unit supplier to ensure compatibility between drive and AC motors.
- B. The drive shall be UL listed and CSA approved, and shall comply with all applicable requirements of the latest standard of ANSI, IEEE and NEMA.
- C. The drive shall be mounted in NEMA 12 enclosure. Drives not located indoors shall have NEMA 4 enclosure. The entire VFD package shall be in a free standing metal enclosure, and be completely factory assembled. Plastic enclosure is not acceptable.
- D. The cabinet shall be front access only. The unit shall be suitable for operation in ambient temperature - 14°F to 104°F (up to 122°F with cover removed).
- E. The drive shall be a PWM (Pulse Width Modulated) transistorized inverter using IGBTs (Insulated Gate Bipolar Transistors) and must be fully digital.
- F. The drive shall have a common design for all horsepower models required for this project.

2.2 VARIABLE FREQUENCY DRIVE

- A. Standard Features
- B. Main input power shall be 400V – 460V/60Hz.
 - 1. The drive shall have a tolerance for voltage $\pm 10\%$ and frequency $\pm 2\text{Hz}$. Overload current shall be 100% continuous and 110% for 1 minute.
 - 2. Interrupting rating (AIC): 65,000 AIC (RMS symmetrical) unless otherwise noted. The use of input fuses to achieve this rating shall not be acceptable. Contractor to verify the rating from the short circuit study prior to furnishing submittal.
 - 3. Automatic cooling fan control based on heat sink temperature for extended fan life.
 - 4. Shall have a built-in control system for commercial power/standby power switching.
 - 5. Shall have an adjustable retry function after a fault, both number of attempts (at least 10) and time between (1-10 sec).
 - 6. Shall have an analog input filter adjustment to limit the effects of noise on the control signal.
 - 7. Shall have the ability to automatically restart after an over current, over voltage, under voltage, or loss of input signal protective trip. The number of restart attempts and trials shall be programmable.
 - 8. Shall have the following user selectable contingencies in the event of loss of analog control signal while the drive is running before loss:
 - a. Run at the user set lower frequency limit.
 - b. Run at the user set upper frequency limit.
 - c. Trip with a signal loss fault.
 - d. Run at user selected percentage of the last valid frequency signal.
- C. Shall be equipped with both local/remote and manual/auto keys on touchpad.
 - 1. Hand-Off-Auto keypad control and manual speed shall be provided on the keypad. When in “Hand”, the VFD will be started, and the speed will be controlled from the speed up or speed down button. Then in “Off”, the VFD will be stopped. When in “Auto”, the VFD will start via an external contact enclosure, and its speed will be controlled via an external speed reference.
 - 2. Shall have capability to manually override existing setting or speed.



3. Shall have the capability of storable special custom user setting.
 4. Shall restart into a rotating motor operating in either the forward or reverse direction and match that frequency.
 5. Shall have adjustable soft stall (10% - 150%) which reduces frequency and voltage of the inverter to sustain a run in an overload situation.
 6. Shall have adjustable UL listed electronic overload protection (10% - 100%).The drive shall have a custom programmable volt/hertz pattern.
 7. Serial RS232C communication standard
 8. Provide BACnet interface for EMS control.
- D. Protective Features
1. Provide phase reversal protection.
 2. Provide input and output line reactors to reduce harmonic noise to 5% THD rms.
 3. Shall have main disconnecting integral input circuit breaker with minimum interrupting rating not less than 110% of the available fault level. Circuit breaker shall be by Square D, General Electric, or equal. The circuit breaker operating mechanism shall be lockable and readily accessible on the outside of the enclosure.
 4. The drive shall be capable of re-setting faults remotely and locally.
 5. The drive shall be programmable to alert the following alarms:
 - a. Over torque alarm,
 - b. Motor overload pre-alarm
 - c. Undercurrent alarm
 - d. Over current pre-alarm
 - e. Communication error alarm
 6. The drive shall identify and display the following faults:
 - a. Over current (350% instantaneous or 170% RMS) during normal run, acceleration or deceleration trip.
 - b. Over current on the DC Bus during normal run trip, acceleration trip, or deceleration trip.
 - c. Over voltage (130% of VFD's rated voltage) during normal (constant speed) run trip, acceleration trip, or deceleration trip.
 - d. Under voltage (65% of the VFD's rated voltage) trip.
 - e. Over temperature.
 - f. Ground Fault either running or at start
 - g. Emergency off trip message.
 - h. RAM, ROM, CPU error
 - i. Communication interruption error
 - j. Output current detection circuit error
 - k. Over torque trip
- E. Monitor Functions
1. The drive digital display shall be capable of displaying the following: frequency, % current, current amps, % voltage I/O, voltage in volts I/O, RPM, GPM, I/O Watts, torque, and input reference signal, kWh.

END OF SECTION 23 05 14



**SECTION 23 05 19
METERS AND GAGES FOR HVAC PIPING**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Thermometers.
 - 2. Thermowells.
 - 3. Dial-type pressure gages.
 - 4. Gage attachments.
 - 5. Test plugs.
 - 6. Test-plug kits.

1.2 ACTION SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of this particular specification section.
 - 1. The manufacturer shall resubmit this specification section showing compliance with each respective paragraphs and specified items and features.
 - 2. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
 - 3. Individual or partial submittals are not acceptable and will be returned without review.
- B. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage, from manufacturer.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ADJUSTABLE ANGLE THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Terrice, H. O. Co.
 - 2. Weiss Instruments, Inc.
 - 3. WIKA Instrument Corporation - USA.
 - a. Standard: ASME B40.200.
 - b. Case in first paragraph below will typically be the sealed (dry) type. Hermetically sealed cases are available.
 - c. Case: V-shape design. cast aluminum.
 - d. Fill type: Blue liquid
 - e. Connector Type(s): Union joint, adjustable angle, lockable.
 - f. Connector Size: 3/4 inch, with ASME B1.1 screw threads.
 - g. Stem: 304 Stainless steel.
 - h. Window: Glass or ultraviolet protective acrylic.
 - i. Scale Size: 9 inches.
 - j. Accuracy: Plus or minus 1 percent of scale range.

2.2 THERMOWELLS

- A. Thermowells:
 - 1. Standard: ASME B40.200.



2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CUNI.
4. Material for Use with Steel Piping: Type 316 stainless steel.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc
 - b. Terrice, H. O. Co.
 - c. Weiss Instruments, Inc.
 - d. WIKA Instrument Corporation - USA.
2. Standard: ASME B40.100.
3. Case: Silicone liquid filled, hermetically sealed, solid-front, pressure relief type; cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 TEST PLUG

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.

1. Peterson Equipment Co., Inc.
2. Sisco Manufacturing Company, Inc.
3. Terrice, H.O. Co.
4. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 275 °F.

F. Core Inserts: Nordel (Ethylene-Propylene self sealing rubber).

2.5 TEST-PLUG KITS

A. Temperature Readout Manufacturer & Model:

1. Fluke Model 116-HVAC with (in addition) 80PK-22 Type K Probe



- B. Pressure Gauge:
 - 1. Ashcroft Series D1005PS General Purpose Digital Gauge, provide (2) pressure gages 0 to 100 PSIG and 0 to 200 PSIG, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. Carrying Case: provide carrying case with foam cutouts to hold Gauges with P/T probes, and a case for the Fluke 80PK-22 Type K Probe.

2.6 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 pipe threads.
- C. Valves: Brass or stainless-steel needle, with NPS 1/4, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermometers in the following locations:
 - 1. Inlet and outlet of air handling chilled water and hot water coil.
 - 2. Entrance and exit of main building service.
- B. Install pressure gages in the following locations:
 - 1. Inlet and outlet of air handling chilled water and hot water coil.
 - 2. Entrance and exit of main building service.
 - 3. Discharge of each pressure-reducing valve.
- C. Install pressure/temperature plug in the following locations:
 - 1. Next to a location of a pressure gauge, temperature gauge, or EMS pressure/temperature sensor location. Can use one plug location for common Temperature / Pressure / EMS readings.

END OF SECTION 23 05 19

SECTION 23 05 23
GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.
 - 2. Iron, single-flange butterfly valves.
 - 3. High-performance butterfly valves.
 - 4. Bronze gate valves.
 - 5. Iron gate valves.
 - 6. Bronze globe valves
 - 7. Chainwheels.
- B. Related Sections:
 - 1. Section 23 05 53 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.4 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set gate and globe valves closed to prevent rattling.
 - 4. Set ball valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Handwheel: For valves other than quarter-turn types.
 - 2. Handlever: For quarter-turn valves NPS 6 and smaller.
 - 3. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Gate Valves: With rising stem.
 - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Grooved: With grooves according to AWWA C606.
 - 3. Solder Joint: With sockets according to ASME B16.18.
 - 4. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES (SIZES ½" THROUGH 2")

- A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES (SIZES 2-1/2" THROUGH 12")

- A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Jenkins Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. DeZurik Water Controls.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.

2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze or ductile iron.

2.4 HIGH-PERFORMANCE BUTTERFLY VALVES (SIZES 2-1/2" THROUGH 12")

- A. Class 150, Single-Flange, High-Performance Butterfly Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Flowseal.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. DeZurik Water Controls.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 2. Description:
 - a. Standard: MSS SP-68.
 - b. CWP Rating: 285 psig at 100 deg F.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: Carbon steel or ductile iron.
 - e. Seat: Reinforced PTFE or metal.
 - f. Stem: Stainless steel; offset from seat plane.
 - g. Disc: Carbon steel.
 - h. Service: Bidirectional.

2.5 BRONZE GATE VALVES (SIZE 2" AND SMALLER)

- A. Class 125, RS Bronze Gate Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron.

2.6 IRON GATE VALVES (SIZES 2-1/2" THROUGH 12")

- A. Class 125, OS&Y, Iron Gate Valves. (Size 3" and Larger):
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.

- d. Milwaukee Valve Company.
- e. NIBCO INC.
- 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.

2.7 BRONZE GLOBE VALVES (SIZES 2" AND SMALLER)

- A. Class 125, Bronze Globe Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron.

2.8 IRON, CENTER-GUIDED CHECK VALVES

- A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 162, gray iron.
 - d. Style: Compact wafer
 - e. Seat: Bronze.
 - f. Spring: Stainless Steel.

2.9 CHAINWHEELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Roto Hammer Industries.
 - 2. Trumbull Industries.
- B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Attachment: For connection to ball and butterfly valve stems.
 - 3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
 - 4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.



PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly, or gate valves.
 - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
 - 3. Throttling Service: Globe, Ball, or high-performance butterfly valves.
 - 4. Pump-Discharge Check Valves
 - a. NPS 2-1/2 and Larger: Iron, center-guided, metal-seat check valves.

3.2 CHILLED-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Ball Valves: Two-piece, full port, stainless-steel trim.
 - 3. Bronze Gate Valves: Class 125, RS, bronze.
 - 4. Bronze Globe Valves: Class 125, bronze disc.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 - 2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
 - 3. High-Performance Butterfly Valves: Class 150, single flange
 - 4. Iron, Center-Guided Check Valves: Class 125, compact-wafer and globe, metal resilient seat.

3.3 HEATING-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Ball Valves: Two-piece, full port, bronze with stainless-steel trim.
 - 3. Bronze Gate Valves: Class 125, RS.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 - 2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
 - 3. High-Performance Butterfly Valves: Class 150, single flange.
 - 4. Iron Gate Valves: Class 125, OS&Y
 - 5. Iron, Center-Guided Check Valves: Class 125, compact-wafer and globe, metal resilient seat.

END OF SECTION 23 05 23

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Valve tags.
 - 5. Warning tags.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. The manufacturer, contractor or supplier shall resubmit the specification section and shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of that particular section. Next to each specification item, indicate the following:
 - 1. "No Exception Taken".
 - 2. "Exception". All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- C. Samples: For color, letter style, and graphic representation required for each identification material and device.
- D. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- E. Valve numbering scheme. See paragraph 2.7.B.
- F. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Manufacturers:
 - 1. Craftmark Identification Systems
 - 2. Seton Identification Products
 - 3. MSI Marking Services
 - 4. Setmark

2.2 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass or anodized aluminum, 0.032-inch minimum thickness and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.



4. Fasteners: Stainless-steel rivets or contact-type permanent adhesive, compatible with label and substrate.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
 1. Material and Thickness: Three-layer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick and having predrilled holes for attachment hardware.
 2. Color Coding:
 - a. Letter Color: White.
 - b. Background Color: Red.
 3. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 6. Fasteners: Stainless-steel rivets or contact-type permanent adhesive, compatible with label and substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.3 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Color Coding:
 1. Background Color: Yellow.
 2. Letter Color: Black.
- C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- F. Fasteners: Stainless-steel rivets or self-tapping screws.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 PIPE LABELS

- A. Do not use pipe labels or plastic tapes for bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher.
- B. General Requirements for Manufactured Pipe Labels: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger pipe sizes may have maximum sheet size with separate fastener.



- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing. Either marker shall show accepted color-coded background, proper color of legend in relation to background color, accepted legend letter size, accepted marker length.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2 inch sequenced numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2 by 11 inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7 inches.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER", "CAUTION" or "DO NOT OPERATE."
 - 4. Color:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.

PART 3 - EXECUTION

3.1 NOT APPLICABLE

END OF SECTION 23 05 53



**SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - 2. Balancing Hydronic Piping Systems:
 - a. Constant-flow hydronic systems.
 - b. Variable-flow hydronic systems.
 - c. Primary-secondary hydronic systems.
 - 3. Testing, Adjusting, and Balancing Equipment:
 - a. Heat exchangers.
 - b. Motors.
 - c. Condensing units.
 - d. Boilers.
 - e. Heat-transfer coils.
 - f. Pumps
 - 4. Testing, adjusting, and balancing existing systems and equipment.
 - 5. Sound tests.
 - 6. Vibration tests.
 - 7. Duct leakage tests.
 - 8. Control system verification.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.

1.3 PREINSTALLATION MEETINGS

- A. TAB Conference: Conduct a TAB conference at Project site with the Engineer and Commissioning Agent after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
 - 1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.

1.4 ACTION SUBMITTALS

- A. LEED Submittals:
 - 1. Air-Balance Report for Prerequisite IEQ 1: Documentation indicating that work complies with ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
 - 2. TAB Report for Prerequisite EA 2: Documentation indicating that work complies with ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."



1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. System Readiness Checklists: Submit system readiness checklists as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.6 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Engage an independent TAB Contractor certified by AABC or NEBB.
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC or NEBB.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC or NEBB as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.



- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.
 - 2. Hydronics:
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.



- b. Piping is complete with terminals installed.
- c. Water treatment is complete.
- d. Systems are flushed, filled, and air purged.
- e. Strainers are pulled and cleaned.
- f. Control valves are functioning per the sequence of operation.
- g. Shutoff and balance valves have been verified to be 100 percent open.
- h. Pumps are started and proper rotation is verified.
- i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
- j. Variable-frequency controllers' startup is complete and safeties are verified.
- k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in ASHRAE Standard 111 or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.



- a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure inlets and outlets airflow.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 6. Measure and record all operating data.
 7. Record final fan-performance data.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Adjust the variable-air-volume systems as follows:
1. Verify that the system static pressure sensor is located at least two-thirds of the distance down the duct from the fan discharge or as shown on the Drawings.
 2. Verify that the system is under static pressure control.
 3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum



- inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
 5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 6. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
 7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
 8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
 9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.
 - g. Verify building pressurization control by measuring building pressure at various operating conditions.



3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 - 1. Check liquid level in expansion tank.
 - 2. Check highest vent for adequate pressure.
 - 3. Check flow-control valves for proper position.
 - 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 - 5. Verify that motor starters are equipped with properly sized thermal protection.
 - 6. Check that air has been purged from the system.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Adjust pumps to deliver total design gpm.
 - 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gage heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - 3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - 1. Measure flow in main and branch pipes.
 - 2. Adjust main and branch balance valves for design flow.
 - 3. Re-measure each main and branch after all have been adjusted.
- C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - 1. Measure flow at terminals.
 - 2. Adjust each terminal to design flow.
 - 3. Re-measure each terminal after it is adjusted.
 - 4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - 5. Perform temperature tests after flows have been balanced.
- D. For systems with pressure-independent valves at terminals:
 - 1. Measure differential pressure and verify that it is within manufacturer's specified range.
 - 2. Perform temperature tests after flows have been verified.
- E. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - 1. Measure and balance coils by either coil pressure drop or by using P/T ports.
 - 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.



- F. Verify final system conditions as follows:
 - 1. Re-measure and confirm that total water flow is within design.
 - 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - 3. Mark final settings.
- G. Verify that memory stops have been set.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.
- B. Adjust the variable-flow hydronic system as follows:
 - 1. Verify that the differential-pressure sensor is located as indicated.
 - 2. Determine whether there is diversity in the system.
- C. For systems with no diversity:
 - 1. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
 - 2. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
 - 3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
 - 4. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
 - 5. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
 - 6. Prior to verifying final system conditions, determine the system differential-pressure set point.



7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
 8. Mark final settings and verify that all memory stops have been set.
 9. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
 10. Verify that memory stops have been set.
- D. For systems with diversity:
1. Determine diversity factor.
 2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
 3. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
 4. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
 5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
 6. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure, and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
 7. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
 8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.



9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
13. Verify that memory stops have been set.

3.10 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

- A. Balance the primary circuit flow first.
- B. Balance the secondary circuits after the primary circuits are complete.
- C. Adjust pumps to deliver total design gpm.
 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gage heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- D. Adjust flow-measuring devices installed in mains and branches to design water flows.
 1. Measure flow in main and branch pipes.
 2. Adjust main and branch balance valves for design flow.
 3. Re-measure each main and branch after all have been adjusted.
- E. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 1. Measure flow at terminals.
 2. Adjust each terminal to design flow.
 3. Re-measure each terminal after it is adjusted.
 4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 5. Perform temperature tests after flows have been balanced.
- F. For systems with pressure-independent valves at terminals:
 1. Measure differential pressure and verify that it is within manufacturer's specified range.
 2. Perform temperature tests after flows have been verified.
- G. For systems without pressure-independent valves or flow-measuring devices at terminals:
 1. Measure and balance coils by either coil pressure drop or temperature method.
 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- H. Verify final system conditions as follows:
 1. Re-measure and confirm that total water flow is within design.



2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

I. Verify that memory stops have been set.

3.11 PROCEDURES FOR STEAM SYSTEMS

- A. Measure and record upstream and downstream pressure of each piece of equipment.
- B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.
- C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
- D. Check settings and operation of each safety valve. Record settings.
- E. Verify the operation of each steam trap.

3.12 PROCEDURES FOR HEAT EXCHANGERS

- A. Adjust water flow to within specified tolerances.
- B. Measure inlet and outlet water temperatures.
- C. Measure inlet steam pressure.
- D. Check settings and operation of safety and relief valves. Record settings.

3.13 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Phase and hertz.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter size and thermal-protection-element rating.
 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.14 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

3.15 PROCEDURES FOR BOILERS

- A. Hydronic Boilers:
 1. Measure and record entering- and leaving-water temperatures.
 2. Measure and record water flow.
 3. Record relief valve pressure setting.

3.16 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 1. Entering- and leaving-water temperature.
 2. Water flow rate.
 3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
 4. Dry-bulb temperature of entering and leaving air.



5. Wet-bulb temperature of entering and leaving air for cooling coils.
 6. Airflow.
- B. Measure, adjust, and record the following data for each electric heating coil:
1. Nameplate data.
 2. Airflow.
 3. Entering- and leaving-air temperature at full load.
 4. Voltage and amperage input of each phase at full load.
 5. Calculated kilowatt at full load.
 6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each steam coil:
1. Dry-bulb temperature of entering and leaving air.
 2. Airflow.
 3. Inlet steam pressure.
- D. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
 2. Wet-bulb temperature of entering and leaving air.
 3. Airflow.

3.17 SOUND TESTS

- A. After the systems are balanced and construction is Substantially Complete, measure and record sound levels at <Insert number> locations as designated by the Architect.
- B. Instrumentation:
1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
 2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (LEQ).
 3. The sound-testing meter must be capable of using 1/3 octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
 4. The accuracy of the sound-testing meter shall be plus or minus one decibel.
- C. Test Procedures:
1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
 2. Equipment should be operating at design values.
 3. Calibrate the sound-testing meter prior to taking measurements.
 4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.
 5. Record a set of background measurements in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment off.
 6. Take sound readings in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment operating.
 7. Take readings no closer than 36 inches from a wall or from the operating equipment and approximately 60 inches from the floor, with the meter held or mounted on a tripod.
 8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.
- D. Reporting:
1. Report shall record the following:
 - a. Location.
 - b. System tested.
 - c. dBA reading.



- d. Sound pressure level in each octave band with equipment on and off.
2. Plot sound pressure levels on NC worksheet with equipment on and off.

3.18 VIBRATION TESTS

- A. After systems are balanced and construction is Substantially Complete, measure and record vibration levels on equipment having motor horsepower equal to or greater than 25.
- B. Instrumentation:
 1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
 2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
 3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
 4. Verify calibration date is current for vibration meter before taking readings.
- C. Test Procedures:
 1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
 2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.
 3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
 4. Record CPM or rpm.
 5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.
- D. Reporting:
 1. Report shall record location and the system tested.
 2. Include horizontal-vertical-axial measurements for tests.
 3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from the AABC National Standards. Acceptable levels of vibration are normally "smooth" to "good."
 4. Include in report General Machinery Vibration Severity Chart, with conditions plotted.

3.19 DUCT LEAKAGE TESTS

- A. Witness the duct pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified tolerances.
- C. Report deficiencies observed.

3.20 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
 1. Verify temperature control system is operating within the design limitations.
 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 3. Verify that controllers are calibrated and function as intended.
 4. Verify that controller set points are as indicated.
 5. Verify the operation of lockout or interlock systems.
 6. Verify the operation of valve and damper actuators.
 7. Verify that controlled devices are properly installed and connected to correct controller.



8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.21 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
1. Measure and record the operating speed, airflow, and static pressure of each fan.
 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 3. Check the refrigerant charge.
 4. Check the condition of filters.
 5. Check the condition of coils.
 6. Check the operation of the drain pan and condensate-drain trap.
 7. Check bearings and other lubricated parts for proper lubrication.
 8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
1. New filters are installed.
 2. Coils are clean and fins combed.
 3. Drain pans are clean.
 4. Fans are clean.
 5. Bearings and other parts are properly lubricated.
 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
 4. Balance each air outlet.

3.22 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 2. Air Outlets and Inlets: Plus or minus 10 percent.
 3. Heating-Water Flow Rate: Plus or minus 10 percent.
 4. Cooling-Water Flow Rate: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.23 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.



- B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.24 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
 - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB specialist.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 - 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outdoor, supply, return, and exhaust airflows.



2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.
- F. Apparatus-Coil Test Reports:
1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft.



- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.
- 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.
 - j. Entering-water temperature in deg F.
 - k. Leaving-water temperature in deg F.
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in deg F.
 - o. Inlet steam pressure in psig.
- G. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btu/h.
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and rpm.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches, and bore.
 - n. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 2. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btu/h.
 - i. High-fire fuel input in Btu/h.
 - j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btu/h.
 - m. Motor voltage at each connection.



- n. Motor amperage for each phase.
- o. Heating value of fuel in Btu/h.
- H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- J. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.



- h. Size.
- i. Effective area in sq. ft.
- 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 - 1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.



- f. Final discharge pressure in feet of head or psig.
- g. Final suction pressure in feet of head or psig.
- h. Final total pressure in feet of head or psig.
- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.

M. Instrument Calibration Reports:

- 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.25 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of commissioning authority.
- B. Commissioning authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- E. If TAB work fails, proceed as follows:
 - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 - 2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
 - 3. If the second verification also fails, Owner may contact AABC or NEBB Headquarters regarding the Performance Guaranty.
- F. Prepare test and inspection reports.

3.26 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93

**SECTION 23 07 13
DUCT INSULATION**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply, return and make-up air.
 - 2. Indoor, exposed supply and return air.
 - 3. Outdoor, exposed supply and make-up air.
- B. Related Sections:
 - 1. Section 23 07 19 "Pipe Insulation."
 - 2. Section 23 31 13 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
 - 3. Detail application of field-applied jackets.
 - 4. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and



field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Owens Corning; SOFTR All-Service Duct Wrap.

2.2 DUCT LINING

- A. Manufacturer:
 - 1. Schuller/Manville
 - 2. Owens-Corning
 - 3. Pittsburgh
 - 4. Certainteed
- B. For the outdoor application use 2 in. lining and for the indoor application use 1-1/2 in. lining.
 - 1. Rectangular ductwork: Fiberglass Schuller/Manville Permacote Linacoustic flexible duct liner insulation with approved fire-resistant coating for erosion control, bonded with a dark thermosetting resin. The airstream surface and long edges shall be protected with acrylic coating. Apply to flat sheets with full coverage adhesive and insulation pins prior to fabrication of ducts or fittings. Lining shall be dual density duct liner. Duct sizes indicated on Drawings are net inside acoustical lining insulation dimensions, increase duct sizes accordingly.
 - 2. Circular ductwork: Fiberglass duct liner manufactured to fit small and large radius round ducts with approved fire-resistant coating for erosion control located as indicated on Drawings. Apply to round ducts with full coverage adhesive prior to fabrication of ducts or fittings. Lining shall be Schuller/Manville Spiracoustic Plus in ducts over 24 in. dia., Schuller/Manville Permacote Spiracoustic in ducts under 24 in. dia. Duct sizes shown are net inside duct liner. Increase duct sizes accordingly. Provide with duct liner adhesive design Polymeric (DP-2502)
 - 3. Line all ductwork as indicated on Drawings.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers".

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 5. Color: White.
- C. Vapor-Barrier Permeance: ASTM 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
 - b. Eagle Bridges - Marathon Industries; 550.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
 - 3. Service Temperature Range: Minus 50 to plus 220 deg F (minus 46 to plus 104 deg C)..
 - 4. Solids Content: ASTM D1644, 33 percent by volume and 46 percent by weight.
 - 5. Color: White.

2.5 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 3. Fire- and water-resistant, flexible, elastomeric sealant.
 - 4. Service Temperature Range: 20 to plus 250 deg F.
 - 5. Color: Aluminum.

6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Use sealants that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II. when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
 - c. RPR Products, Inc.; Insul-Mate.
 2. Sheet and roll stock ready for shop or field sizing.
 3. Finish and thickness are indicated in field-applied jacket schedules.
 4. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper 3-mil- thick.
 5. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper 2.5-mil- thick polysurlyn.

2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, provide the following:
 - a. ABI, Ideal Tape Division; 491 AWF FSK.



- b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - c. Compac Corporation; 110 and 111.
 - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
- 2. Width: 3 inches.
 - 3. Thickness: 6.5 mils.
 - 4. Adhesion: 90 ounces force/inch in width.
 - 5. Elongation: 2 percent.
 - 6. Tensile Strength: 40 lbf/inch in width.
 - 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.9 SECUREMENTS

- A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
- B. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
 - b. GEMCO; Peel & Press.
 - c. Midwest Fasteners, Inc.; Self Stick.
 - 2. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - 3. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - 4. Adhesive-backed base with a peel-off protective cover.
- C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. AGM Industries, Inc.; RC-150.
 - b. GEMCO; R-150.
 - c. Midwest Fasteners, Inc.; WA-150.
 - d. Nelson Stud Welding; Speed Clips.
 - e. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- D. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- E. Wire: 0.062-inch soft-annealed, stainless steel.
 - 1. Manufacturers: Subject to compliance with requirements, provide product by:
 - a. C & F Wire, or equal.

PART 3 - EXECUTION

3.1 NOT APPLICABLE

END OF SECTION 23 07 13



**SECTION 23 07 19
HVAC PIPING INSULATION**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Heating Hot Water piping, indoors and outdoors.
 - 2. Chilled Water piping, indoors and outdoors.

1.2 ACTION SUBMITTALS

- A. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at pipe expansion joints for each type of insulation.
 - 3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 4. Detail removable insulation at piping specialties.
- B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied), if any.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.



- A. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

2.2 GLASS FIBER

- B. Manufacturers: Owens-Corning Fiberglass 25 ASJ/SSL, Johns Manville Micro-Lok, Certainteed, Knauf or equal.
- C. Type I, 850 deg F Materials; Mineral or glass fibers bonded with thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ-SSL jacket. Factory applied jacket requirements are specified in "Factory Applied Jackets" Article.

2.3 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 - 2. Width: 3 inches.
 - 3. Thickness: 11.5 mils
 - 4. Adhesion: 90 ounces force/inch in width.
 - 5. Elongation: 2 percent.
 - 6. Tensile Strength: 40 lbf/inch in width.
 - 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 491 AWF FSK.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - c. Compac Corporation; 110 and 111.
 - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
 - 2. Width: 3 inches.
 - 3. Thickness: 6.5 mils.
 - 4. Adhesion: 90 ounces force/inch in width.
 - 5. Elongation: 2 percent.
 - 6. Tensile Strength: 40 lbf/inch in width.
 - 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.4 SECUREMENTS

- A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch 3/4 inch wide with closed seal.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, stainless steel.
 - 1. Manufacturers: Subject to compliance with requirements, provide product by:
 - a. C & F Wire.

2.5 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Metal Jacket Jacket: Aluminum jacket shall comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005,



Temper H-14; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules. Moisture Barrier for Outdoor Applications: 3-mil thick, heat bonded polyethylene and kraft barrier.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Preformed 2-piece or gore, 45- and 90- degree, short- and long-radius elbows.
 - b. Tee covers.
 - c. Flange and union covers.
 - d. End caps.
 - e. Beveled collars.
 - f. Valve covers.

PART 3 - EXECUTION

3.1 NOT APPLICABLE

END OF SECTION 23 07 19



**SECTION 23 09 00
INSTRUMENTATION AND CONTROL FOR HVAC**

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for cooling units not supplied with factory-wired controls.
- B. Related Sections include the following:
 - 1. Section 23 05 19 "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
- C. Definitions:
 - 1. Alarm: Notification of an abnormal condition.
 - 2. Algorithm: A logical procedure for solving a recurrent mathematical problem.
 - 3. Analog: A continuously varying signal value (temperature current, velocity, etc.)
 - 4. Application Generic Controller (AGC): A networked device or node that contains a complete, configurable application that is generic in nature and suited for various control tasks. The device manufacturer produces this application. The manufacturer exposes a high number of network variables and configuration properties on the device to allow the specific use of the device to be configured with network tools.
 - 5. Application Specific Controller (ASC): A networked device or node that contains a complete, configurable application that is specific to a particular task. This application is normally produced by the device manufacturer and contains a number of configuration parameters that may be adjusted by network tools.
 - 6. Binary: A two-state system where an "on" condition is represented by a high signal level and an "off" condition is represented by a low signal level.
 - 7. Bridge: A device that routes messages or isolates message traffic to a particular segment sub-net or domain of the same physical communication media.
 - 8. Building Automation System (BAS): The complete facility control system comprised of all mechanical system automation, and automatic temperature control, etc., as defined in the contract documents. The BAS is built upon a single network infrastructure based upon BACnet protocol. This infrastructure may include field wiring, BACnet wiring, routers, bridges, raceways, and gateways as required connecting noninteroperable subsystems and devices.
 - 9. Channel: A physical media serving a number of nodes. All nodes on any given channel 'hear' messages produced by other nodes on the channel. The network configuration and node application program determines whether or not a device responds to the messages.
 - 10. Control Unit: A BACnet control product that handles multiple inputs and outputs and more than one control loop. May utilize a supplemental general-purpose microprocessor in addition to the standard BACnet chip to perform additional functions or software applications.
 - 11. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and PE switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operation.
 - 12. Custom Application Controller (CAC): Programmable control product that incorporates solid-state components to perform control loops or functions. The application in the controller is custom software produced by the Control System Contractor specifically for the project. These applications shall conform to BACnet functional profiles and interoperability standards. Complete documentation including object diagrams, Device Resource Files (DRF), and External Interface Files (XIF) must be submitted EOR (Engineer of Record) when such devices/controllers are used.
 - 13. Deadband: A temperature range over which no heating or cooling energy is supplied, such as 72-78 degrees F, i.e. as opposed to single point changeover or overlap.



14. Device Resource File: External Interface files and BACnet plug-ins that are required to display manufacturer's defined network variables or configuration parameters correctly.
15. DDC: Direct digital control.
16. Distributed Control: A system whereby all control processing is decentralized and independent of a central computer.
17. Diagnostic Program: A machine-executable program with instructions used to detect and isolate system and component malfunctions.
18. Domain: A domain is logical collection of nodes on one or more channels. Communications can only take place among nodes configured in a common domain; therefore, a domain forms a virtual network. Multiple domains can occupy the same channels, so domains may be used.
19. Gateway: A device that contains an I/O software driver to translate data from other protocols to the conforming BACnet standards.
20. Graphical User Interface (GUI): A graphical subset of operator interfaces.
21. HVAC Control Systems: The complete BACnet Control System comprising User Interface, routers, gateways, repeaters, Control Units (CU), software, portable operators terminals, network communications wiring and raceways, and required field hardware, etc.
22. Intelligent Devices: BACnet product that is configured to provide control over a single control loop or to monitor a single or multiple control variable(s); incorporates solid-state components based upon BACnet protocol to perform dedicated functions (ex: actuators, sensors, and switches).
23. Man-Machine Interface (MMI): A graphical, object-oriented method by which an operator is capable of communicating with the system. The Man-Machine interface allows the operator to manage, control, monitor, and configure the system.
24. Network: A system of distributed control devices that are linked together on a communication bus. A network allows sharing of point information between all control devices. Additionally, a network may provide central monitoring and control of the entire system from an MMI/GUI.
25. Node: An intelligent device attached to the network. Usually falls into one of the following categories - sensor, actuator, ASC, AGC, CAC.
26. Operator Interface: A device combination of hardware and software, (PC, laptop or display terminal) which provides client access to the control system, primarily used for network management, configuration, and diagnostics.
27. Operating System (OS): Software which controls the execution of computer programs.
28. Peripheral: External devices used to communicate to and from a computer. Peripherals include CRT, printer, hard drives, disk drives, modems, etc.
29. Point: Group of data, which corresponds to a hardware input, output, or calculated value.
30. Portable Operator's Terminal (POT): Laptop/tablet device that allows local and remote access to the local control network.
31. Router: A device that routes or forwards messages destined for a node on another subnet or domain of the control network. The device controls message traffic based on node address and priority. Routers may also serve as communication interfaces between different channel media. (i.e., powerline, twisted pair, Ethernet\TCP\IP, and RF)
32. Segment: A set of channels connected by bridges or repeaters. A node sees every packet from every other node on its segment.
33. Sensor: Device capable of measuring the condition or value of a variable.
34. Software: Programs and routines used to extend the capabilities of computers hardware.
35. Subnet: A subnet is a logical collection of up to 127 nodes within a domain. Up to 255 subnets can be defined within a single domain. All nodes in a subnet must be on the same segment. Subnets cannot cross-intelligent routers.

D. Abbreviations

1. AAC Advanced Application Controllers
2. AGC Application Generic Controller
3. ASC Application Specific Controller



- 4. BAS Building Automation System
- 5. BC Building Controllers
- 6. CAC Custom Application Controller
- 7. DDC Direct Digital Controller
- 8. DRF Device Resource File
- 9. FAS Facility Automation System
- 10. FPM Feet per minute
- 11. GPM Gallons per minute
- 12. GUI Graphical User Interface
- 13. I/O Input/Output
- 14. NFPA National Fire Protection Association
- 15. OS Operating System
- 16. OWS Operating Work Station
- 17. PE Pneumatic-electric
- 18. PID Proportional Integral Derivative
- 19. PRV Pressure Reducing Valve
- 20. PSI(g) Pounds per square inch (gauge)
- 21. RAM Random Access Memory
- 22. SA Smart Actuators
- 23. SS Smart Sensors
- 24. TCS Temperature Control System
- 25. TCC Temperature Control Contractor
- 26. UL Underwriters' Laboratory
- 27. VCS Voice Communication System
- 28. WC Water Column
- 29. XIF External Interface File

1.2 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
 - 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
 - 3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
 - 4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
 - 5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
 - 6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
 - 7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.

1.3 QUALITY ASSURANCE

- A. The Building Automation System (BAS) shall be furnished, engineered and installed by a certified Distec controls system supplier and approved by the Owner Representative.
- B. System Integrator shall:
 - 1. Be in good standing with the Manufacturer.
 - 2. Have on staff, trained Integrators.
 - 3. Have at least four (4) fully trained programming staff members at all times.



4. Provide training class certifications of staff members if requested.
 5. Have direct line of technical support from suppliers.
 6. Employ technicians who have completed factory-authorized training.
 7. Employ technicians to provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.
- C. The installing Contractor must be regularly engaged in the service and installation of Distec based systems as specified herein.
- D. The installing Contractor shall have an office within 200 miles that is staffed with designers trained in integrating interoperable systems and technicians fully capable of providing instruction and routine emergency maintenance service on all system components.
- E. The installing Contractor shall have in house capabilities to provide control strategies for whole building control. This includes HVAC, lighting, access, and security applications etc.
- F. The installing Contractor shall have a service facility, staffed with qualified service personnel, capable of providing instructions and routine emergency maintenance service for networked control systems.

1.4 ACTION SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of this particular specification section.
1. The manufacturer shall resubmit this specification section showing compliance with each respective paragraphs and specified items and features.
 2. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
 3. Individual or partial submittals are not acceptable and will be returned without review.
- B. The installing Contractor shall provide project list stating completion of no less than three (3) construction projects of similar size or larger within the past five (5) years, which have BacNET based BAS as specified herein installed by the Contractor. These projects must be on-line and functional such that the system can be observed in full operation.
- C. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
 3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Bill of materials of equipment indicating quantity, manufacturer and model number.
 2. Schematic flow diagrams showing fan coil units, air handlers, condensers, boilers, pumps, valves and control devices and accessories.
 3. Wiring Diagrams: Power, signal and control wiring.
 4. Details of control panel faces, including controls, instruments and labeling.
 5. Written description of sequence of operation.
 6. Schedule of valves including flow characteristics.
 7. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.



- b. Schematic diagrams and floor plans for field sensors and control hardware.
- c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
- 8. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
- 9. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.
 - d. Points list.

1.5 INFORMATIONAL SUBMITTALS

- A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- B. Qualification Data: For Installer and manufacturer.
- C. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- D. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For direct digital control system to include in emergency, operation, and maintenance manuals. Include the following:
 - 1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 - 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 - 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - 5. Calibration records and list of set points.
- B. Software and Firmware Operational Documentation: Include the following:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
 - 5. Software license required by and installed for DDC workstations and control systems.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.8 COORDINATION

- A. Coordinate location of exposed control sensors with plans and room details before installation.
- B. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- C. Coordinate equipment with Section 262416 "Panelboards" to achieve compatibility with starter coils and annunciation devices.



PART 2 - PRODUCTS

2.1 SOLE SOURCE ITEMS

- A. The following products are Board of Trustees approved sole source items. No substitutions will be accepted.
 - 1. HVAC Building Controller: "Tridium" JACE 8000 (with driver).
 - 2. Terminal Unit Controller: "Eclipse" Distech Controls.
 - 3. VAV Controller: "Eclipse" Distech Controls.
 - 4. Connected System Controller: "Eclipse" Distech Controls, ECY-S1000 Series.

2.2 CONTROL SYSTEM

- A. Control system manufacturer shall be Distec to match campus standard, or owner approved contractor able to meet the specifications of this section.
- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- C. The selected Distec Controls System Contractor shall be fully responsible to install all graphics required under this project. Provide necessary software, devices, upgrades, modifications, etc. as required for a fully operational direct digital controls (DDC) system.

2.3 COMMUNICATION

- A. The design of the Building Management and Control System (BMCS) shall network operator workstations and Stand-Alone DDC Controllers through the Ethernet network provided by Owner's IT Department. The network architecture shall consist of multiple levels for communication efficiency, a campus-wide (Management Level Network) Ethernet network based on TCP/IP protocol, high performance peer-to-peer building level network(s) and DDC Controller floor level local area networks.
- B. The design of BAS shall allow the co-existence of new DDC Controllers with existing DDC Controllers in the same network without the use of gateways or protocol converters.
 - 1. System shall have the capability to communicate with a BACnet network over Ethernet or BACnet/IP (according to Annex J). The intent is to use the system provided under this contract to communicate with control systems provided by other vendors. PICS must be provided describing the BACnet, ANSI/ASHRAE 135-2001 implementation. Minimum system functionality must include monitoring, commanding, and alarming for daily operator functions from a common workstation.
 - 2. System shall have the capability to be an OPC Client and Server for dynamic communication with OPC Clients or Servers over an Ethernet network. At a minimum, the following must be supported:
 - a. Data Access 1.0 (96), 1.0A (97) and 2.0 (11/98)
 - b. Alarms & Events 1.0 (1/99)
- C. Access to system data shall not be restricted by the hardware configuration of the system. The hardware configuration of the BMCS network shall be totally transparent to the user when accessing data or developing control programs.
- D. Peer-to-Peer Management & Building Level Networks (MLN & BLN):
 - 1. Operator workstations and DDC Controllers shall directly reside on an Ethernet network such that communications may be executed directly between DDC Controllers, directly between workstations, and between DDC Controllers and workstations on a peer-to-peer basis.
 - 2. All operator devices either network resident or connected via dial-up modems, shall have the ability to access all point status and application report data or execute control and maintenance functions for any and all devices via the peer-to-peer network.



3. The BMCS shall operate as a true token-pass peer-to-peer communication network. Resident processors in each DDC panel shall provide for full exchange of system data between other DDC Panel's on the network trunk.
4. Network design shall include the following provisions:
 - a. Provide high-speed data transfer rates for alarm reporting, quick report generation from multiple controllers and upload/download efficiency between network devices. System performance shall insure that an alarm occurring at any DDC Controller is displayed at workstations and/or alarm printers within five seconds.
 - b. Support of any combination of DDC Controllers and operator workstations directly connected to the peer-to-peer network. A minimum of 32 devices shall be supported on a single network.
 - c. Message and alarm buffering to prevent information from being lost
 - d. Error detection, correction and re-transmission to guarantee data integrity
 - e. Synchronization of real-time clocks including automatic daylight savings time updating between all DDC Controllers, shall be provided.
 - f. The peer-to-peer network shall support a minimum of 100 DDC controllers and PC workstations
 - g. Each PC workstation shall support a minimum of 4 peer-to-peer networks hardwired or dial up.
 - h. The system shall support integration of third party systems (fire alarm, security, lighting, PCL, chiller, boiler) via panel mounted open protocol processor. This processor shall exchange data between the two systems for inter-process control. All exchange points shall have full system functionality as specified herein for hardwired points. Field panels must be capable of integration with open
 - i. Standards including Modbus, BACnet, and LonWorks as well as with third party devices via existing vendor protocols
- E. The peer-to-peer Building Level Network shall use the TCP/IP over Ethernet. All devices must:
 1. Auto-sense 10/100 Mbps networks.
 2. Receive an IP Address from a Dynamic Host Configuration Protocol (DHCP) Server or be configured with a Fixed IP Address.
 3. Resolve Name to IP Addresses for devices using a Domain Name Service (DNS) Server on the Ethernet network.
 4. Allow access using Telnet.
- F. DDC Controller Floor Level Network (FLN):
 1. This level of communication shall support a family of application-specific controllers such as terminal box controllers and heat pump controllers and shall communicate bi-directionally with the peer-to-peer network through DDC Controllers for transmission of global data.
 2. Application specific controllers shall be arranged on the FLN in a functional relationship manner with DDC Controllers. For example, a VAV terminal box in a functional relationship manner with DDC Controllers is controlling its corresponding VAV fan system.
 3. Provide Terminal Equipment Controllers with field adjustable PID gains and biases. Controllers that incorporate proportional and integral (PI) control algorithms only, shall not be acceptable.

2.4 HVAC MECHANICAL EQUIPMENT CONTROLLERS

- A. HVAC Mechanical Equipment Controllers shall be Tridium JACE 8000 with drivers. Drivers shall be appropriate for the application of communication.
- B. HVAC Mechanical Equipment Controllers shall be a 12-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors.
- C. Each HVAC Mechanical Controller shall have sufficient memory to support its own operating system and databases, including:
 1. Control processes
 2. Energy management applications



3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
 4. Historical/trend data for points specified
 5. Maintenance support applications
 6. Custom processes
 7. Operator I/O
 8. Remote communications
- D. HVAC Mechanical Equipment Controllers shall provide a RS-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals.
- E. HVAC Mechanical Equipment Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
- F. Each HVAC Mechanical Equipment Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all components. The HVAC Mechanical Equipment Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
- G. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
1. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V
 2. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
 3. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
 4. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)
 5. Isolation shall be provided at all peer-to-peer panels' AC input terminals to suppress induced voltage transients consistent with:
 - a. IEEE Standard 587-1980
 - b. UL 864 Supply Line Transients
 - c. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)
- H. The Controls Contractor shall provide an uninterrupted power supply for every HVAC mechanical equipment controller to prevent the loss of database or operating system software in the event of the loss of normal power. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
1. Upon restoration of normal power, the HVAC Mechanical Equipment Controller shall automatically resume full operation without manual intervention.
 2. Should HVAC Mechanical Equipment Controller memory be lost for any reason, the user shall have the capability of reloading the HVAC Mechanical Equipment Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.

2.5 DDC & HVAC MECHANICAL EQUIPMENT CONTROLLER RESIDENT SOFTWARE FEATURES

- A. General:
1. The software programs specified in this Section shall be provided as an integral part of DDC and HVAC Mechanical Equipment Controllers and shall not be dependent upon any higher level computer for execution.
 2. All points shall be identified by up to 30-character point name and 16 character point descriptor. The same names shall be used at the PC workstation.
 3. All digital points shall have user defined two-state status indication [descriptors with minimum of 8 characters allowed per state (i.e. summer/winter)].



- B. Control Software Description:
 - 1. The DDC and HVAC Mechanical Equipment Controllers shall have the ability to perform the following pre-tested control algorithms:
 - a. Two-position control
 - b. Proportional control
 - c. Proportional plus integral control
 - d. Proportional, integral, plus derivative control
 - e. Automatic tuning of control loops
- C. DDC and HVAC Mechanical Equipment Controllers shall provide the following energy management routines for the purpose of optimizing energy consumption while maintaining occupant comfort.
 - 1. Start-Stop Time Optimization (SSTO) shall automatically be coordinated with event scheduling. The SSTO program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by time of occupancy. The SSTO program shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period, and still maintain desired comfort conditions.
 - a. The SSTO program shall operate in both the heating and cooling seasons.
 - b. It shall be possible to apply the SSTO program to individual fan systems.
 - c. The SSTO program shall operate on both outside weather conditions as well as inside zone conditions and empirical factors.
 - d. The SSTO program shall meet the local code requirements for minimum outside air while the building is occupied.
 - 2. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or groups of points according to a stored time.
 - a. It shall be possible to individually command a point or group of points.
 - b. For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start and stop within that group.
 - c. The operator shall be able to define the following information:
 - 1) Time, day
 - 2) Commands such as on, off, auto, and so forth.
 - 3) Time delays between successive commands.
 - 4) There shall be provisions for manual overriding of each schedule by an appropriate operator.
 - d. It shall be possible to schedule events up to one year in advance.
 - 1) Scheduling shall be calendar based.
 - 2) Holidays shall allow for different schedules.
 - 3. Economizer switchover. The Energy Management Control Software (EMCS) will control the position of the air handler relief, return, and outside air dampers. If the outside air dry bulb temperature falls below changeover set point, the EMCS will modulate the dampers to provide 100 percent outside air. The user will be able to quickly changeover to an economizer system based on dry bulb temperature and will be able to override the economizer cycle and return to minimum outside air operation at any time.
 - 4. Temperature-compensated duty cycling.
 - a. The DCCP (Duty Cycle Control Program) shall periodically stop and start loads according to various patterns.
 - b. The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.
 - 5. Automatic Daylight Savings Time Switchover: The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.
 - 6. Night setback control: The system shall provide the ability to automatically adjust set points for night control.



7. The Peak Demand Limiting (PDL) program shall limit the consumption of electricity to prevent electrical peak demand charges.
 - a. PDL shall continuously track the amount of electricity being consumed, by monitoring one or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.
 - b. PDL shall sample the meter data to continuously forecast the demand likely to be used during successive time intervals.
 - c. If the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads.
 - d. Once the demand peak has passed, loads that have been shed shall be restored and returned to normal control.
- D. DDC and HVAC Mechanical Equipment Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
 1. A single process shall be able to incorporate measured or calculated data from any and all other DDC and HVAC Mechanical Equipment Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC and HVAC Mechanical Equipment Controllers on the network. Database shall support 30 character, English language point names, structured for searching and logs.
 2. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.
 3. DDC and HVAC Mechanical Equipment Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.
 4. DDC and HVAC Mechanical Equipment Controller shall be capable of comment lines for sequence of operation explanation.
- E. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC and HVAC Mechanical Equipment Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC and HVAC Mechanical Equipment Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
 1. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
 2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC and HVAC Mechanical Equipment Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
 3. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after hour's destinations) or based on priority.
 4. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.
 5. In dial-up applications, operator-selected alarms shall initiate a call to a remote operator device.
- F. A variety of historical data collection utilities shall be provided in order to manually or automatically sample, store and display system data for points as specified in the I/O summary.
 1. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC and HVAC Mechanical Equipment Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time



interval or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided. Each DDC and HVAC Mechanical Equipment Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of ___ data samples. All trend data shall be available for transfer to a Workstation without manual intervention.

2. DDC and HVAC Mechanical Equipment Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.
 - a. Loop tuning shall be capable of being initiated either locally at the DDC and HVAC Mechanical Equipment Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.
- G. DDC and HVAC Mechanical Equipment Controllers shall be capable of automatically accumulating and storing run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule.
- H. The peer to peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to access any data from or send control commands and alarm reports directly to any other DDC and HVAC Mechanical Equipment Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC and HVAC Mechanical Equipment Controllers shall send alarm reports to multiple workstations without dependence upon a central or intermediate processing device. The peer to peer network shall also allow any DDC and HVAC Mechanical Equipment Controller to access, edit, modify, add, delete, back up, and restore all system point database and all programs.
- I. The peer to peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust and control the points that the operator is authorized for. All other points shall not be displayed on the PC workstation or portable terminal (e.g. all base building and all tenant points shall be accessible to any base building operators, but only tenant points shall be accessible to tenant building operators). Passwords and priorities for every point shall be fully programmable and adjustable.

2.6 ROOM PRESSURIZATION CONTROLLERS

- A. VAV Room Pressurization Controllers shall be a networked, stand-alone controller designed for the specific application of volumetric offset room control. Units utilizing room differential pressure monitors as a control point are not acceptable. Providers using two controllers to control room pressure will not be accepted. Room pressure monitors may be a monitored point for compliance in isolation rooms. The manufacturer of the controller shall be able to demonstrate a history of product performance in the healthcare industry and local installations of at least five years of age.

2.7 TERMINAL EQUIPMENT CONTROLLERS (TEC)

- A. UL listing 916 and UL 864. Provide one Terminal Equipment Controller (TEC) for each zone. TEC's shall be fully electronic and shall be connected to an MEC via Floor Level Network trunk. The TEC shall provide PID control by means of Direct Digital Control (DDC).
- B. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) gains for all applications. All PID gains and biases shall be field-adjustable by the user via terminals as specified herein. Controllers that incorporate proportional and integral (PI) control algorithms only shall not be acceptable.
- C. TEC Memory: The TEC shall utilize EEPROM memory for storing set points and control parameters. The TEC shall return from power loss without operator intervention. Systems that require reprogramming after power loss are not acceptable.



- D. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable laptop or similar operators' terminal to control and monitor all hardware and software points associated with the controller. In lieu of an internal jack, provide a separate terminal jack mounted on a stainless steel wall plate adjacent to the sensor to facilitate direct access to the controller via the terminal.
- E. Each room sensor shall include Setpoint Adjustment, Temperature Indicator, and Override Switch.
- F. The setpoint adjustment shall allow for modification of the temperature by the occupant. Setpoint adjustment may be locked out, overridden or limited as to time or temperature through software by an authorized operator at the central workstation, DDCP or via the portable programming tool. In lieu of an integral adjustment dial, provide a separate dial mounted on a stainless steel wall plate adjacent to the sensor to perform the specified functionality.
- G. The override switch shall initiate override of the night setback mode to normal (day) operation when activated by the occupant. The override function may be locked out, overridden or limited as to the time through software by an authorized operator at the central workstation, DDCP or via the portable programming tool. In lieu of an integral switch, provide a separate momentary contact switch mounted on a wall plate adjacent to the sensor to perform the specified functionality.
- H. Each controller shall perform its primary control function independent of other DDCP network communication, or if network communication is interrupted. Reversion to a fail-safe mode of operation during network interruption is not acceptable. Should the controller reside on a DDCP network, the controller shall receive its real-time data from the DDCP clock to insure network continuity.
- I. Each controller shall have connection provisions for a portable laptop or similar operators' terminal. This connection shall be possible at both the controller and at the matching room temperature sensor as previously specified. The terminal may be used for readout of system variables, override control, adjustment of control parameters, air balancing, servicing and troubleshooting. The terminal shall provide the user with the following functionality as a minimum:
 - 1. Display system status (heating, cooling, etc.)
 - 2. Display all point values and setpoints
 - 3. Set and change all setpoints
 - 4. Set and change heating/cooling dead-bands
 - 5. Set and change PID loop gains
 - 6. Set and change system mode (occupied/unoccupied)
 - 7. Set and change system mode times
 - 8. Override all setpoints
 - 9. Override all digital and analog outputs
 - 10. Command all digital and analog outputs
 - 11. Select application mode
 - 12. Assign controller address
- J. The TEC shall operate with 24 volt AC power. Provide 120/24 transformers. The 120 volt power supply to each TEC is provided under Division 26.

2.8 THERMOWELLS

- A. When thermowells are required, the sensor and well shall be supplied as a complete assembly including wellhead and Greenfield fitting.
- B. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
- C. Thermowells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
- D. Thermowells shall be constructed of machined stainless steel, Type 316.
- E. Manufacturer shall be BAPI Model BA/4"M316 or approved equal.



- F. Provide Honeywell 107408 heat conductive compound in each thermowell.

2.9 LIQUID IMMERSION TEMPERATURE SENSORS & TRANSMITTER

- A. Temperature Sensor: BAPI Model 1K8 or approved equal.
 - 1. Operating Temperature: -40 to 185°F
 - 2. Sensing Element: 1000 Ohm 385 Curve RTD
 - 3. Accuracy at Calibration Temperature: +/- 0.27 °F
- B. Temperature Transmitter: Minco Model TT807
 - 1. Min / Max Span: 35°F to 1112°F
 - 2. Accuracy: +/- 0.1% of Span
 - 3. Linearity: +/- 0.1% of Span
- C. All sensors measuring temperatures in pipes larger than 2 inches in diameter or in pressure vessels shall be supplied with wells properly fabricated for the service. Wells shall be non-corrosive to the medium being measured and shall have sufficient physical strength to withstand pressures and velocities to which they are subjected. Wells shall be installed in the piping at elbows where piping is smaller than the length of the well to affect proper flow across the entire area of the well.
- D. Stainless steel, Type 304, socket with minimum insertion length of 4 inches.

2.10 OUTSIDE AIR TEMPERATURE AND HUMIDITY SENSORS

- A. Vaisala HUMICAP Outdoor Humidity and Temperature Transmitter HMD60YO. No known equal.
 - 1. Humidity Operating Range: 0-100% RH
 - 2. Humidity Output Signal: 4 to 20 mA, 0 to 100% linear, proportional
 - 3. Humidity Accuracy: +/- 2.0% RH, 0-90% RH
 - 4. Humidity Sensing Element: HUMICAP 180
 - 5. Temperature Range: -40-140°F
 - 6. Temperature Output Signal: 4 to 20 mA, 0 to 100% linear, proportional
 - 7. Temperature Accuracy: ± 0.36°F
 - 8. Temperature Sensing Element: 1K-ohm Platinum RTD 1/3 Class B IEC 751
- B. Outdoor installations shall be of weatherproof construction or in appropriate NEMA enclosures. These installations shall be protected from solar radiation and wind effects. They shall also be provided with a solar radiation shield.

2.11 DUCT TYPE TEMPERATURE SENSORS

- A. BAPI or approved equal.
 - 1. Operating Temperature: -40 to 240°F
 - 2. Sensing Element: NTC 10K (Type II) Thermistor
 - 3. Accuracy at Calibration Temperature: +/- 1 °F
- B. Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only and shall not be located in dead air spaces, in close proximity to coils so as to display inaccurate temperatures, or positions obstructed by ducts, equipment, and so forth. Locations where installed shall be within the vibration and velocity limit of the sensing element.
- C. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement. A neoprene grommet (Seal-tite fitting and mounting plate) shall be used on the sensor assembly to prevent air leaks.
- D. Duct sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate. Duct sensors probe shall be constructed of 304/316 stainless steel.
- E. Duct sensors shall not be mounted within 36 inches of heating and cooling coils.
- F. For outdoor air duct applications, use a weatherproof mounting box with weatherproof cover and gasket.

2.12 AVERAGING DUCT TYPE TEMPERATURE SENSORS



- A. Minco 1000 Ohm 375 Platinum Averaging Sensor & T90PNR Temperature Transmitter.
 - 1. Operating Temperature: -40 to 240°F
 - 2. Sensing Element: 1000 Ohm 375 Curve RTD
 - 3. Accuracy at Calibration Temperature: +/- 0.6 °F
- B. For ductwork that has a dimension greater than 48 inches and/or where air temperature stratification exists, utilize an averaging sensor with multiple sensing points. The averaging sensor shall be installed complete with end cap, compression fittings, gaskets, mounting flange and required accessories.
- C. Provide CC-1G-K capillary supports at the sides of the duct to support the sensing string.

2.13 ROOM TEMPERATURE SENSORS

- A. Room sensors are to be provided with digital display, setpoint adjustment and tool port.
- B. Room sensors to be hard-wired. Wireless sensors are not permitted.
- C. Room sensors are to be provided with a cover to prevent accidental damage.
 - 1. Temperature Measuring Range: 32 to 122°F
 - 2. Temperature Accuracy: ±0.9°F
 - a. Sensing Element: NTC 10 K (Type II) Thermistor

2.14 ROOM CO2 SENSORS

- A. Telaire 8102, GE Ventostat T8100, AirTest EE80-2CT or approved equal.
- B. CO2 sensors shall be certified by the manufacturer to have an accuracy of 400-1250 ppm ±30 ppm or 3% of reading (whichever is greater), factory calibrated or calibrated at start-up, and certified by the manufacturer to require calibration no more frequently than once every 5 years.
- C. The sensors shall use dual beam, non-dispersive infrared absorption (NDIR) CO2 sensor with gold-plated optics.
- D. The CO2 sensors shall have no more than 2% drift during the life of the sensor (15 years).
- E. The units shall be wall-mounted type as indicated on plans and in the Sequence of Operations and shall be provided with a NEMA 1 white plastic cover, without LED indicator.
- F. The sensor shall meet the following requirements:
 - 1. Operating Temperature: -23 to 113 °F
 - 2. Operating voltage: 13.5 to 35 VDC
 - 3. CO2 measuring range: 0 to 2000 ppm
 - 4. Accuracy: +/- 75 ppm
 - 5. Output: 0 – 10 VDC, 0-100% Linear

2.15 AIR DIFFERENTIAL PRESSURE TRANSMITTERS

- A. Air differential pressure sensors shall be Setra Model 269 transmitters with digital display or approved equal.
- B. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input.
- C. Provide a minimum of a NEMA 1 housing for the transmitter. Locate transmitters in accessible local control panels wherever possible.
- D. The pressure transmitter shall be capable of transmitting a linear electronic signal proportional to the differential of the room and reference static pressure input signals with the following minimum performance specifications.
 - 1. Span: Refer to Points List
 - 2. Accuracy: ±0.5% of full scale
 - 3. Non-Repeatability: ±0.05%
 - 4. Non-Linearity: ±0.35%



5. Response: Less than one second for full span input.
6. Temperature Stability: Less than 0.02%FS/°F change
7. Output: 4 to 20 mA

2.16 WATER DIFFERENTIAL PRESSURE TRANSMITTERS

- A. Water differential pressure sensors shall be Setra Model 230 transmitters or approved equal.
- B. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input.
- C. Provide:
 1. NEMA 1 transmitter housing and locate in accessible local control panels wherever possible.
 2. Brass 3-valve manifold assembly with shut-off and shunt valves.
 3. Standard Viton/Silicone bleed screw seals.
 4. Calibration certificate.
- D. The pressure transmitter shall be capable of transmitting a linear electronic signal proportional to the differential of the pressure input signals with the following minimum performance specifications.
 1. Span: Refer to Points List
 2. Accuracy: $\pm 0.25\%$ of full scale
 3. Non-Repeatability: 0.05%
 4. Non-Linearity: $\pm 0.20\%$
 5. Response: 30 to 50 ms
 6. Temperature Stability: Less than 0.02%FS/°F change
 7. Output: 4 to 20mA

2.17 AIRFLOW MEASUREMENT

- A. Airflow Measurement
 1. Provide Ebtron Gold Series thermal dispersion airflow and temperature measurement device (ATMD) equipped with 'C' sensor density probes or approved equal.
 2. The ATMD shall include the GTL116 industrial grade integrated transmitter and the BACnet network communication. The static pressure manifold shall incorporate dual offset static tips on opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as $\pm 20^\circ$ in the approaching air stream.
 3. The Calibrated Range: .0 to 5,000 fpm
 4. The Operating Temperature: Probe: -20 to 160°F Transmitter: -20 to 120°F.
 5. Operating Humidity Range: .0 to 99% non-condensing; Transmitter must be protected from exposure to precipitation
- B. Transmitter and Enclosure
 1. Transmitter Construction: Heavy duty with industrial grade IC's and rugged aluminum chassis with sliding cover
 2. Transmitter Dimensions: 9.251 x 6.688 x 2.5 in (HxWxD)
 3. Transmitter Mounting: Four 0.188 in dia mounting holes located 0.75 in from top/bottom, and 0.375 from left/right edges on integral mounting plate
- C. Sensor Probes
 1. Factory Calibrated Sensor
 2. Accuracy: Airflow: $\pm 2\%$ of reading
 3. Temperature: $\pm 0.15^\circ\text{F}$
 4. Probe Construction: Type 6063 gold anodized aluminum
 5. Mounting Brackets: Type 304 SS
 6. Probe Dimensions: Alum: 1.1 in diameter
 7. Standard Size Ranges: 8 to 120 in for Insertion/Standoff Mount 12 to 120 in for Internal Mount



8. Maximum Quantity Probes / Sensing Nodes: 4 probes per transmitter; 8 sensing nodes per probe; 16 nodes total max.
 9. Probe/Transmitter Cable: 10 ft. [3.05 m] plenum rated FEP cable, positive locking connector with gold plated pins (Optional cable length of up to 50 feet)
- D. Output Interface
1. BACnet.
 2. Repeatability: 0.25% of reading
 3. Airflow Output Signal Filter: Adjustable 0 to 99% (via pushbutton interface)
 4. Airflow Low Limit Cutoff: Forces output to zero below a user specified value

2.18 THERMAL-ENERGY METERS (CHILLED WATER AND HEATING HOT WATER)

- A. Onicon System 10-BAC MS/TP BTU Meter. No known equal.
- B. Provide system with flow sensor, temperature sensors, transmitter, indicator and connecting wiring for interface via BACnet MS/TP based Disctec system.
- C. Electromagnetic, insertion flow sensor (no moving parts) with corrosion-resistant-metal body and transmitter for installation in piping. Onicon F-3200 Series.
1. Design: Total thermal-energy measurement.
 2. Minimum Pressure Rating: 150 psig.
 3. Minimum Temperature Range: 15 to 250 deg F.
- D. Temperature Sensors.
1. Manufactured by Onicon.
 2. Solid-state sensors calibrated using NIST traceable temperature standards.
 3. Differential temperature accuracy $\pm 0.15^{\circ}\text{F}$ over calibrated range.
- E. Indicator: Solid-state, integrating-type meter for wall mounting.
1. Sixteen character alphanumeric LCD display.
 2. Display Data: total energy, total flow, energy rate, flow rate, supply temperature and return temperature.
- F. Accuracy: Plus or minus 0.05 percent computing non-linearity.
- G. Display: Visually indicates total energy, total flow, energy rate, flow rate, supply and return temperature.
- H. Output Interface: BacNET MS/TP compatible transceiver high-speed interface.

2.19 NATURAL GAS FLOW AND TOTALIZING METER

- A. Provide natural gas (Methane) flow meter model 620S by Sierra Instruments or approved equal. Integration shall be through MODBUS. See plumbing drawings for location and quantity.
- B. Performance Specifications:
1. Accuracy of Point Velocity: - +/- 1% of full scale
 2. Repeatability: - +/- 0.2% of full scale
 3. Temperature Coefficient: - +/- 0.02% of reading per $^{\circ}\text{F}$ within +/- 50°F of customer specified conditions, +/- 0.03% of reading per $^{\circ}\text{F}$ within +/- 50°F to 100°F of customer specified conditions +/- 0.04% of reading per $^{\circ}\text{C}$ within +/- 25°C of customer specified conditions, +/- 0.06% of reading per $^{\circ}\text{C}$ within +/- 25°C to 50°C of customer specified conditions
 4. Pressure Coefficient: .02% per psi for air, consult factory for other gases
 5. Response Time: 200 milliseconds to 63% of final velocity value
- C. Operating Specifications:
1. Gas Pressure: 120 psig maximum design pressure
 2. Pressure Drop: Negligible
 3. Gas & Ambient Temperature: Gas -40° to 176°F , Ambient -40° to 120°F
 4. Power Requirements: 18 to 30 VDC (regulated), 625 mA maximum



5. Output Signal: Linear 0–5 VDC or 0-10 VDC, 1000 ohms minimum load resistance or Linear 4–20 mA proportional to mass flow rate, 700 ohms maximum resistance power supply dependent User-selectable. Active non-galvanically separated or, passive galvanically separated (loop power required)
6. Alarms: Hard contact user-adjustable high and low, Dead band adjustable with Smart Interface™ software, Relay ratings maximum 42 VAC or 42 VDC, 140 mA
7. Displays: Alphanumeric 2 x 12 digit backlit LCD Adjustable variables via on-board switches (password protected) or, with Smart Interface™ software, Adjustable variables. . Full scale (50 to 100 %)Time Response (1 to 7 seconds) Correction factor setting (0.5 to 5) Zero and span
8. Totalizer: Eight digits (9,999,999) in engineering units, Resettable by software, on-board switches or external magnet

2.20 CURRENT TRANSFORMERS

- A. The current transformers shall be provided to be installed or removed without dismantling the primary bus or cables. The transformer shall be of a split core design.
- B. The core and windings shall be completely encased in a UL approved thermoplastic rated 94VA. No metal parts shall be exposed other than the terminals.
- C. The current transformers shall meet the following specifications.
 1. Frequency Limits: 50 to 400 Hz.
 2. Insulation: 0.6 KV Class, 10 KV BIL.
 3. Accuracy: $\pm 1\%$ at 5.0 to 25.0 VA accuracy class with U.P.F. burden.
 4. Provide a disconnect switch for each current transformer.

2.21 CURRENT SENSING SWITCHES

- A. Current sensing switch shall be self-powered with solid-state circuitry and a dry contact output.
- B. Current sensing switches shall consist of a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over current up to twice its trip into range.

2.22 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 1. Comply with requirements in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
 2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 1. Manufacturers shall be Belimo Aircontrols (USA), Inc.
 2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
 3. Coupling: V-bolt and V-shaped, toothed cradle.
 4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 5. Provide external, manual gear release on nonspring-return actuators.
 6. Power Requirements (Two-Position): 24-V ac.
 7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 9. Temperature Rating: 40 to 104 deg F.



10. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F
11. Run Time: 60 seconds.

2.23 CONTROL VALVES

- A. Manufacturer shall be Belimo Aircontrols or approved equal.
- B. Control Valves: Factory fabricated, of type, body material and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- C. Ball Valves:
 1. NPS 2 and Smaller: 400 psi brass body, nickel plated, stainless steel trim, PTFE seats and screwed ends.
 2. NPS 2-1/2 and 4: 400 psi brass body, nickel plated, stainless steel trim, PTFE seats and flanged ends.
 3. Sizing:
 - a. Two Position: Line size.
 - b. Two-Way Modulating: As specified on the Drawings with Tefzel characterizing disc.
 4. Flow Characteristics: Two-way valves shall have equal percentage characteristics.
 5. Close-Off or Differential Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 200 psig.
- D. High Performance Butterfly Valves:
 1. Maximum close-off or differential pressure of 150 psig, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
 2. Body Style: Lug.
 3. Disc Type: Nickel-plated ductile iron.
 4. Sizing: 1-psig maximum pressure drop at design flow rate.

2.24 ELECTRICAL BULK MATERIALS

- A. The controls contractor shall be fully responsible to provide all wiring (low voltage, 120 volts, etc.) and conduit (3/4" minimum or as required by electrical codes) for connection of all associated DDC HVAC devices and control valves, sensors, panels and any other DDC components for a completely operational DDC system.
 1. The controls contractor shall be fully responsible to coordinate with their electrical subcontractor, prior to bid, to insure that all necessary electrical power wiring and conduit are provided for the new HVAC system, devices, control valves, control panels, etc.
- B. Enclosures: Terminal boxes located indoors shall be rated for NEMA 1. Terminal boxes exposed to outdoors shall be rated for NEMA 12. Terminal boxes with potential water leakage shall be rated for NEMA 4X. They shall have protective coatings suitable to the environment in which they are to be installed. All enclosures shall be hinged with lockable doors.
- C. Transformers: Provide step-down transformers where control equipment operates at lower than circuit voltage. Transformers serving shall be fed from the fan motor leads, or fed from the nearest distribution panelboard or motor control center, using circuits provided for the purpose. Transformers, other than transformers in bridge circuits, shall have primaries wound for the voltage available and secondaries wound for the correct control circuit voltage. Size transformers so that 80 percent of the rated capacity equals the connected load. Enclose transformers in a steel cabinet with conduit connections. Provide a disconnect switch on the primary side and a fuse cutout on the secondary side. Transformers shall conform to UL 506.
- D. The Controls Contractor shall furnish all electrical relays and coordinate with the supplier of magnetic starters for the auxiliary contact requirements. All electrical control devices shall be of a type to meet current, voltage, and switching requirement of their particular application. Relays shall be provided with 24 VAC coils and contacts shall be rated at 10 amps minimum.



E. Wiring:

1. Provide complete electric wiring for all temperature control apparatus, including wiring to transformer primaries, panels, valves, etc.
2. Control circuit conductors which run in same conduit as power circuit conductors shall have same insulation level as power circuit conductors.
3. Circuits operating at more than 100 volts shall be in accordance with Division 26.
4. Circuits operating at 100 volts or less shall be defined as low voltage and shall be run in rigid or flexible conduit, metallic tubing, metal raceways or wireways, armored cable, or multiconductor cable. Use multiconductor cable for concealed accessible locations only. Provide circuit and wiring protection as required by NFPA 70. Aluminum-sheathed cable or aluminum conduit may be used but shall not be buried in concrete.
5. Provide all exposed wiring shall be in rigid conduit (minimum ¾") or EMT. Refer to Division 26 for different usages of rigid conduit, EMT, or IMT. All wiring in return air plenums shall be plenum rated.
6. For less than nominal 120V service: Cable in control panels for analog loops shall be twisted and shielded two conductor, #16 x 30 stranded with #22 AWG drain wire and aluminum-polyester 100 percent shielding cover for each pair. Cable outside of control panels for analog signal loops shall be single twisted #18 AWG shielded pair. Conductors shall be copper coated with Class B strand. Insulation shall be 30 mils XPLE rated at 300 volts. Cable for digital signals shall be two conductor, #16 x 30 stranded. Each conductor shall be color coded. Each cable shall have polyethylene jacket.
7. Wire for low voltage DC and electronic circuits carrying less than 0.5 ampere, cable of two or more conductors, shall be not smaller than No. 18 AWG stranded copper (shielded).
8. Shield cables carrying analog signals and install in separate conduit from AC power circuits.
9. Terminate cables in solder or screw type terminal strips. Do not tap cables at intermediate points.
10. Color code or number wires, whether individual or in cables, for identification.
11. Cables terminating in screw type terminal strips shall have pressure type connectors conforming to UL 486A. Wire in physical contact with compression screw is not acceptable.

2.25 NETWORK COMMUNICATION REQUIREMENTS

- A. Wired network communication shall follow the published guidelines for twisted pair BacNET network.
- B. Communication conduits shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible. Where communication wire must cross high power wire (deemed as 110VAC or greater) it must do so at right angles.
- C. All shields shall be grounded (earth ground) at one point only to eliminate ground loops. All shield grounding shall be done at the controller location with the shield at the sensor/device end of the applicable wire being left long and "safed" off in an appropriate manner.
- D. There shall be no power wiring, in excess of 30 VAC rms, run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, all communication wiring and signal wiring shall be run using separate twisted pairs (24awg) in accordance with the manufacturer's wiring practices.

2.26 INPUT/OUTPUT CONTROL WIRING

- A. RTD wiring shall be two-wire or four-wire twisted, shielded, minimum number 22 gauge.
- B. Other analog inputs shall be a minimum of number 22 gauge, twisted, (shielding optional).
- C. Binary control function wiring shall be a minimum of number 18 gauge.
- D. Analog output control functions shall be a minimum of number 18 gauge, twisted, shielded.
- E. Binary input wiring shall be a minimum of number 18 gauge.



2.27 SPLICES

- A. Splices in shielded cables shall consist of terminations and the use of shielded cable couplers, which maintain the integrity of the shielding. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties as specified herein.

2.28 CONDUIT AND FITTINGS

- A. Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.
- B. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.
- C. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.
- D. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

2.29 RELAYS

- A. Relays other than those associated with digital outputs shall be general-purpose, enclosed plug-in type with 8-pin octal plug and protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.
- B. Relays associated with digital outputs shall have the ability to override the controlled equipment as a function of the relay. Relays shall be protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.

2.30 IDENTIFICATION

- A. Automatic Control Valve Tags
 - 1. For valves, etc., use metal tags with a 2-inch minimum diameter, fabricated of brass, stainless steel or aluminum. Attach tags with chain of same materials. For lubrication instructions, use linen or heavy duty shipping tag.
 - 2. Tag valves with identifying number and system. Number valves by floor level, column location and system served.
 - 3. Prepare lists of all tagged valves showing location, floor level, and tag number, use. Prepare separate lists for each system. Include copies in each maintenance manual.
- B. Wire Tags
 - 1. All multi-conductor cables in all pull boxes and terminal strip cabinets shall be tagged.
 - 2. Provide wire Tags as per Division 26.
- C. Conduit Tags
 - 1. Provide tagging or labeling of conduit so that it is always readily observable which conduit was installed or used in implementation of this Work.
- D. Miscellaneous Equipment Identification
 - 1. Screwed-on, engraved black lamicoide sheet with white lettering on all control panels and remote processing panels. Lettering sizes subject to approval.
 - 2. Inscription, subject to review and acceptance, indicating equipment, system numbers, functions and switches. For panel interior wiring, input/output modules, local control panel device identification.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that systems are ready to receive work.
- B. Beginning of installation means installer accepts existing conditions.



- C. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Owner Representative for resolution before rough-in work is started.
- D. The contractor shall inspect the site to verify that equipment is installable as show, and any discrepancies, conflicts, or omissions shall be reported to the Owner Representative for resolution before rough-in work is started.
- E. The Controls Contractor shall examine the drawings and specifications for other parts of the work, and if head room or space conditions appear inadequate or if any discrepancies occur between the plans and his work and the plans for the work of others, he shall report such discrepancies to the Owner Representative and shall obtain written instructions for any changes necessary to accommodate his work with the work of others.

3.2 INSTALLATION, GENERAL

- A. Install routers and repeaters as required to combine different communication channels onto a central field bus or as required to segment groups of Intelligent Devices and/or Control Units.
- B. Install Intelligent Control Devices, Programmable Controllers, and Application Specific Controllers as herein specified, as needed to perform functions indicated in the input/output summaries and sequences of operation, and/or indicated on the HVAC drawings.
- C. Install wire, raceway systems, conduit, 24 VDC and/or 24 VAC power supplies and final connections to nodes provided by this contract. Must comply with Division 26 requirements.
- D. Provide 120 VAC power to control panel locations. The controls contractor shall be fully responsible to provide all wiring (low voltage, 120 volts, etc.) and conduit (3/4" minimum or as required by electrical codes) for connection of all associated DDC sensors, panels, valves, and any other DDC components for a completely operational DDC system.
- E. Install all required devices, sensors, hardware, software, wiring, controllers, etc. including any required and not specifically addressed in this specification but required for system functionality. It shall be the responsibility of the Contractor to provide a complete and functional system.
- F. Install all control components in accordance with manufacturer's instructions and recommendations.
- G. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide nameplates for instruments and controls inside cabinet and nameplates on cabinet face.
- H. After completion of installation, test and adjust control equipment. Submit data showing setpoints and final adjustments of controls.
- I. Install equipment, piping, wiring/conduit parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- J. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- K. Connect and configure equipment and software to achieve sequence of operation specified.
- L. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- M. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- N. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
- O. Verify location of temperature, humidity and other sensors, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
 - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.



- P. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."
- Q. Install hydronic instrument wells, valves, and other accessories according to Section 232113 "Hydronic Piping."
- R. Provide BTU meters on CHW and HHW systems.
- S. Provide natural gas meter on each building connection.
- T. Provide main building meter at main service to building. Coordinate submetering requirements with the College on a project-by-project basis.
- U. All meters shall be remoted to the BMS front end. Coordination with Division 22 and 26 for additional requirements.
- V. All exhaust fans shall be controlled via the BMS.
- W. BMS shall monitor status of all damper and valve positions.

3.3 ELECTRICAL SYSTEM INSTALLATION

- A. Comply with all Division 16 Installation Requirements.
- B. Install low voltage power and LAN communication trunks in conduit in the following locations regardless of local building code allowances otherwise.
 - 1. Mechanical rooms
 - 2. Electrical rooms
 - 3. Vertical risers (exception: fire rated continuous closet like a telephone closet)
 - 4. Open Areas where the wiring will be exposed to view or tampering
- C. Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls and ceilings.
- D. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:
 - 1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
 - 2. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.
 - 3. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
 - 4. Where Class 2 wiring is run exposed, wiring to be run parallel along a surface or perpendicular to it, and NEATLY tied at 3m (10 ft.) intervals minimum.
 - 5. Cabling are supported every 10' away from electrical conduit and ballasts. Extra cabling shall be neatly coiled and supported.
- E. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire- to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- F. Plug or cap all unused conduit openings and stub-ups. Do not use caulking compound.
- G. Route all conduit to clear beams, plates, footings and structure members. Do not route conduit through column footings or grade beams.
- H. Set conduits as follows:
 - 1. Expanding silicone fire stop material sealed watertight where conduit is run between floors and through walls of fireproof shaft.
 - 2. Cap open ends of conduits until conductors are installed.



3. Where conduit is attached to vibrating or rotating equipment, flexible conduit with a minimum length of 18 inches and maximum length of 36 inches shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.
4. Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.

3.4 CLEANING

- A. The Controls Contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his (or his subcontractors) control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.
- B. At the completion of work in any area, the Controls Contractor shall clean all of his/her work, equipment, etc., making it free from dirt and debris, etc.
- C. At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.5 PROTECTION

- A. The Controls Contractor shall protect all work and material from damage by his/her work or workers or sub-contractors, and shall be liable for all damage thus caused.
- B. The Controls Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Controls Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on-site that is not immediately installed. The Controls Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.6 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 2. Test and adjust controls and safeties.
 3. Test each point through its full operating range to verify that safety and operating control set points are as required.
 4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 5. Test each system for compliance with sequence of operation.
 6. Test software and hardware interlocks.
- B. DDC Verification:
 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 2. Check instruments for proper location and accessibility.
 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 4. Check instrument tubing for proper fittings, slope, material, and support.
 5. Check installation of air supply for each instrument.
 6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
 7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 8. Check temperature instruments and material and length of sensing elements.
 9. Check control valves. Verify that they are in correct direction.



10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
 11. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.
- C. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.7 ADJUSTING

- A. Calibrating and Adjusting:
1. Calibrate instruments.
 2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
 3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
 4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
 5. Flow:
 - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - b. Manually operate flow switches to verify that they make or break contact.
 6. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
 7. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
 8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
 9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
 10. Provide diagnostic and test instruments for calibration and adjustment of system.
 11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.8 CALIBRATION

- A. The following devices shall be factory calibrated prior to installation and calibration certificates shall be provided by the manufacturer. The device will have to be field calibrated (4-20 mA of VDC signal to GUI/Trend value):



1. Water flow meters
 2. Air differential pressure sensors
 3. Water differential pressure sensors
 4. Humidity sensors
- B. The following devices shall be factory and field(4-20 mA signal to GUI/Trend value) calibrated after installation:
1. RTD temperature sensors
 2. Thermistor Sensors (If it is not an offset calibration but varies with span outside of accuracy, replace the sensor)
 3. Current switches
 4. Air flow sensors

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

3.10 TRAINING

- A. Provide a minimum of four (4) classroom training sessions, four (4) hours each, throughout the contract period for personnel designated by the Owner.
- B. Train the Owner staff to enable them to proficiently operate the system; create, modify and delete programming; add, remove and modify physical points for the system, and perform routine diagnostic and troubleshooting procedures.
- C. Additional training shall be available in courses designed to meet objectives as divided into three logical groupings; participants may attend one or more of these, depending on the level of knowledge required:
1. Day-to-day Operators
 2. Advanced Operators
 3. System Managers/Administrators
- D. Provide course outline and materials as per Part 1 of this Section. The instructor(s) shall provide one copy of training material per student.
- E. The instructor(s) shall be factory-trained instructors experienced in presenting this material.
- F. Classroom training shall be done using a network of working controllers representative of the installed hardware or at the customer's site. This training shall be made available in addition to the interactive audio-visual tutorial, provided with the system.

3.11 ACCEPTANCE

- A. The control systems will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of the Owner Representatives.
- B. Controls contractor shall work with TAB contractor to ensure proper balancing of the building. Refer to 23 05 93 "Testing, Adjusting, and Balancing".
- C. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Owner's Representative. Such tests shall then be performed as part of the warranty.

END OF SECTION 23 09 00

**SECTION 23 21 13
HYDRONIC PIPING**

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
 - 1. Chilled-water piping.
 - 2. Hot-water heating piping
 - 3. Air-vent piping.
 - 4. Safety-valve-inlet and -outlet piping.

1.2 DEFINITIONS

- A. PTFE: Polytetrafluoroethylene.

1.3 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
 - 1. Chilled-Water Piping 125 psig at 200 deg F.
 - 2. Hot-Water Heating Piping 125 psig at 200 deg F.
 - 3. Air-Vent Piping: 200 deg F.
 - 4. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 2. Air control devices.
 - 3. Chemical treatment.
 - 4. Hydronic specialties.
 - a. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Welding certificates.
- C. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."



- C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Wrought-Copper Fittings: ASME B16.22.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc.
 - b. S. P. Fittings; a division of Star Pipe Products.
- C. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53, black steel with plain ends; ERW, grade B, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.
- C. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
- D. Forged-Steel Flanges and Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding, fittings.
 - 3. Flanges: Raised face, slip-on or flat.

2.3 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. Jomar International Ltd.
 - e. Matco-Norca, Inc.
 - f. McDonald, A. Y. Mfg. Co.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - h. Wilkins; a Zurn company.
 - 2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F, 150 psig, 250 psig .
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

- C. Dielectric Flanges:
 - 1. Manufacturer: Subject to compliance with requirements. Provide products by one of the following:
 - a. Capitol Manufacturing Company
 - b. Central Plastics Company
 - c. Matco-Norca, Inc.
 - d. Watts Regulator Co.; a Division of Watts Water Technologies, inc.
 - e. Wilkins; a Zurn Company
 - 2. Description:
 - a. Standard: ASSE 1079
 - b. Factory-fabricated, bolted, companion-flange assembly
 - c. Pressure Rating: 175 psig
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure rating: 150 psig
 - c. Gasket: Neoprene or phenolic
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers
- E. Dielectric Nipples:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elster Perfection
 - b. Grinnell Mechanical Products
 - c. Matco-Norca, Inc.
 - d. Precision Plumbing Products, Inc.
 - e. Victaulic Company
 - 2. Description:
 - a. Standard: IAPMO PS 66
 - b. Electroplated steel nipple. Complying with ASTM F 1545.
 - c. Pressure Rating: 300 psig at 225 deg F.
 - d. End Connections: Male threaded
 - e. Lining: Inert and non-corrosive, propylene.

2.4 AIR CONTROL DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Amtrol, Inc.
 - 2. Armstrong Pumps, Inc.
 - 3. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - 4. Taco.
- B. Manual Air Vents:
 - 1. Body: Bronze.
 - 2. Internal Parts: Nonferrous.
 - 3. Operator: Screwdriver or thumbscrew.
 - 4. Inlet Connection: NPS 1/2.

5. Discharge Connection: NPS 1/8.
 6. CWP Rating: 150 psig.
 7. Maximum Operating Temperature: 225 deg F.
- C. Automatic Air Vents:
1. Body: Bronze or cast iron.
 2. Internal Parts: Nonferrous.
 3. Operator: Noncorrosive metal float.
 4. Inlet Connection: NPS 1/2
 5. Discharge Connection: NPS 1/4
 6. CWP Rating: 150 psig
 7. Maximum Operating Temperature: 240 deg F

2.5 HYDRONIC PIPING SPECIALTIES

- A. Y-Pattern Strainers:
1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 4. CWP Rating: 125 psig.
- B. T-Pattern Strainers:
1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
 2. End Connections: Grooved ends.
 3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
 4. CWP Rating: 750 psig.
- C. Stainless-Steel Bellow, Flexible Connectors:
1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
 2. End Connections: Threaded or flanged to match equipment connected.
 3. Performance: Capable of 3/4-inch misalignment.
 4. CWP Rating: 150 psig.
 5. Maximum Operating Temperature: 250 deg F.
- D. Spherical, Rubber, Flexible Connectors:
1. Body: Fiber-reinforced rubber body.
 2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
 3. Performance: Capable of misalignment.
 4. CWP Rating: 150 psig.
 5. Maximum Operating Temperature: 250 deg F.
- E. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Hot-water heating piping, aboveground, NPS 2-1/2" and smaller, shall be the following:
1. Type L drawn-temper copper tubing, wrought-copper fittings, and soldered brazed joints.
- B. Chilled-water piping, aboveground, NPS 2-12" and smaller, shall be the following:
1. Type L draw-temper copper tubing, wrought-copper fittings, and soldered brazed joints.
- C. Hot-water heating piping, aboveground, NPS 3" and larger shall be the following:
1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- D. Chilled-water piping, aboveground, NPS 3" and larger shall be the following:



1. Schedule 40 steel pipe, wrought-steel fittings and wrought-case or forged-steel flanges and flange fittings, and welded and flanged joints.
- E. Air-Vent Piping:
1. Inlet: Same as service where installed.
 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- F. Makeup-water piping installed above ground shall be the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
 2. Condensate-Drain Piping: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

3.2 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

END OF SECTION 23 21 13

SECTION 23 21 13.13
UNDERGROUND HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section specifies cased piping system.

1.2 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:
 - 1. Chilled Water Piping: 100 psig at 100 deg F.
 - 2. Heating Hot-Water Piping: 100 psig at 200 deg F.

1.3 ACTION SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware or accessory complies with the requirement of this particular specification section.
 - 1. The manufacturer shall resubmit this specification section showing compliance with each respective paragraphs and specified items and features.
 - 2. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
 - 3. Individual or partial submittals are not acceptable and will be returned without review.
- B. Product Data: Provide the following:
 - 1. Cased piping: Carrier piping material, insulation material and K-value, jacket material and end seal construction.
- C. Shop Drawings: Manufacturer shall provide shop drawings for underground hydronic piping.
 - 1. Calculate requirements for expansion compensation for underground piping.
 - 2. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement in the required locations. Show anchors and guides that restrain piping movement with calculated loads.
 - 3. Show pipe sizes, locations, and elevations. Show piping in trench and cased pipe with details showing clearances between piping, and show insulation thickness.

1.4 INFORMATIONAL SUBMITTALS

- A. Profile Drawings:
 - 1. Show system piping in elevation.
 - 2. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and at vertical scale of not less than 1 inch equals 5 feet.
 - 3. Indicate manholes, valve boxes and piping.
 - 4. Show types, sizes, materials, and elevations of other utilities crossing hydronic piping.
- B. Qualification Data: For qualified Installer.
 - 1. Material Test Reports: For cased piping.
 - 2. Source quality-control reports.
 - 3. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
- B. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.
- C. Supply all equipment and accessories new and free from defects.
- D. Supply all equipment and accessories in compliance with the applicable standards listed in this section and with all applicable national and state codes.



- E. Cased Piping Certification:
 - 1. Detailed literature that notes compliance with reference standards. Include type, pressure rating, schedule, class and grade.

PART 2 - PRODUCTS

2.1 PRE-INSULATED STEEL PIPING SYSTEM

- A. Description: Factory-fabricated piping with carrier pipe, insulation, casing and end seals. All pre-insulated pipe, fittings, insulated materials, and technical support shall be provided by the Pre-Insulated Piping System Manufacturer.
 - 1. Manufacturers:
 - 2. Thermacor Process.
 - 3. Rovanco Piping Systems.
 - 4. Perma-Pipe
- B. Carrier Pipe:
 - 1. Standard Weight ASTM A53, Grade B, Carbon Steel pipe and fittings.
- C. Insulation shall be:
 - 1. Polyurethane foam either spray applied or injected with one shot into the annular space between carrier pipe and jacket and shall be bonded to both.
 - 2. Insulation shall be:
 - 3. Minimum 1-1/2 inch thick or greater.
 - 4. Rigid, 90-95% closed cell polyurethane
 - 5. 2.0 to 3.0 pounds per cubic foot density
 - 6. Coefficient of thermal conductivity (K-Factor) of 0.16.
 - 7. Conform to ASTM C-591.
 - 8. Maximum operating temperature of urethane shall not exceed 300 degrees F.
 - 9. Polyurethane foam insulation shall be tested by the manufacturer for mechanical and thermal properties to assure compliance with the values indicated below. All test samples will be taken from production material, identified, tagged and tested. Test reports showing results will be furnished to the College Representative for review. Data supplied by the polyurethane foam chemical supplier is not acceptable.

Insulation	Standard	Frequency	Requirement
Density	ASTM-D1622	Once per batch	≥2.0 lbs/ft ³
Compression Strength	ASTM-D1621	Once per batch	≥30.0 psi
Closed Cell Content	ASTM-D2856	Once per batch	≥90.0%
Thermal Conductivity	ASTM C-518	Once per batch	0.16 BTU-inch/hr/ ft ² /°F

- D. Casing or Jacketing material shall be:
 - 1. Extruded, seamless, black, high density polyethylene (HDPE) in accordance with ASTM D1248, Type 3, Class C.
 - 2. Minimum wall thickness: 100 mils for jacket sizes less than or equal to 6 inches.
- E. End seals shall be:
 - 1. Factory applied:
 - 2. Moisture barrier end seals shall be factory applied and fully sealed to the jacket and carrier pipe and fittings.
 - 3. End seals shall be certified as having passed 20-foot head pressure test. Factory Certificate of Compliance stating that manufacturer's pipe end seals meet the head pressure test requirement is acceptable.



- 4. End seals shall be the same as the jacket on the straight lengths of pipe or a shrink shrinkable end seal that is specifically made for each pipe size.
- F. Field applied:
 - 1. For pipes cut in the field, the pre-insulated piping manufacturer shall provide loose end seals to protect the exposed insulation.
 - 2. End seal shall be a single piece, polyethylene molded heat shrink end seal that is specifically designed for each pipe size.
 - 3. Mastic or paint applied end seal is not acceptable.
- G. All joints shall be welded.

2.2 PRE-INSULATED HDPE PIPING SYSTEM

- A. Description: Factory-fabricated piping with carrier pipe, insulation, casing and end seals. All pre-insulated pipe, fittings, insulated materials, and technical support shall be provided by the Pre-Insulated Piping System Manufacturer.
 - 1. Manufacturers:
 - 2. Thermacor Process.
 - 3. Rovanco Piping Systems.
 - 4. Perma-Pipe
- B. Carrier Pipe:
 - 1. High density polyethylene (HDPE), conforming to ASTM D-3350. Pipe shall be fabricated to Standard Dimension Ratio (SDR) wall thickness of SDR-11 or 160 psi at 73°F.
- C. Insulation shall be:
 - 1. Polyurethane foam either spray applied or injected with one shot into the annular space between carrier pipe and jacket and shall be bonded to both.
 - 2. Insulation shall be:
 - a. Minimum 1-1/2 inch thick or greater.
 - b. Rigid, 90-95% closed cell polyurethane
 - c. 2.0 to 3.0 pounds per cubic foot density
 - d. Coefficient of thermal conductivity (K-Factor) of 0.16.
 - e. Conform to ASTM C-591.
 - f. Maximum operating temperature of urethane shall not exceed 300 degrees F.
 - g. Polyurethane foam insulation shall be tested by the manufacturer for mechanical and thermal properties to assure compliance with the values indicated below. All test samples will be taken from production material, identified, tagged and tested. Test reports showing results will be furnished to the College Representative for review. Data supplied by the polyurethane foam chemical supplier is not acceptable.

Insulation	Standard	Frequency	Requirement
Density	ASTM-D1622	Once per batch	≥2.0 lbs/ft3
Compression Strength	ASTM-D1621	Once per batch	≥30.0 psi
Closed Cell Content	ASTM-D2856	Once per batch	≥90.0%
Thermal Conductivity	ASTM C-518	Once per batch	0.16 BTU-inch/hr/ ft²/°F

- D. Casing or Jacketing material shall be:
 - 1. Extruded, seamless, black, high density polyethylene (HDPE) in accordance with ASTM D1248, Type 3, Class C.
 - 2. Minimum wall thickness: 100 mils for jacket sizes less than or equal to 6 inches.
 - 3. No tape jacket allowed.



4. The inner surface of the HDPE jacket shall be oxidized by means of corona treatment, flame treatment, or other approved methods. This will ensure a secure bond between the jacket and foam insulation preventing any ingress of water at the jacket/foam interface.
- E. Straight Run Joints:
 1. Butt fusion welded and field insulated using urethane foam to the thickness specified and jacketed with heat shrink tape. Joints can be made beside the trench or inside the trench.
- F. Fittings:
 1. Shall be butt fusion-welded to adjacent pipe sections. Fittings that are butt fusion welded in the field are not insulated. End sealed at uninsulated fittings shall be field applied mastic moisture barriers. If fittings are factory manufactured, fittings are pre-insulated using factory PE fitting covers welded to the jackets.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Not Applicable.

3.2 PIPING APPLICATION

- A. Hot Water Piping: Pre-Insulated Steel.
- B. Chilled Water Piping: Pre-Insulated HDPE

3.3 IDENTIFICATION

- A. Install continuous plastic underground warning tapes during back filling of trenches for underground hydronic piping. Locate tapes 6 to 8 inches below finished grade, directly over piping. See Section 31 20 00 "Earth Moving" for warning-tape materials and devices and their installation.
- B. Detectable Warning Tape: Acid and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; color shall be Blue for water piping
- C. Install warning tape directly above utilities, 6-8 inches below finished grade, except 6 inches below subgrade under pavements and slabs. Warning tape to include description of utility.

END OF SECTION 23 21 13.13

**SECTION 23 31 13
METAL DUCTS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Single-wall round and flat-oval ducts and fittings.
 - 3. Sheet metal materials.
 - 4. Duct liner.
 - 5. Sealants and gaskets.
 - 6. Hangers and supports.
 - 7. Seismic-restraint devices.
- B. Related Sections:
 - 1. Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
 - 2. Section 23 33 00 "Air Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Air distribution systems shall be fully ducted from the equipment to the air inlets and outlets. Open-air/return plenum systems are prohibited.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Liners and adhesives.
 - 2. Sealants and gaskets.
 - 3. Seismic-restraint devices.
- B. Shop Drawings:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.
 - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 - 4. Elevation of top of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Fittings.
 - 7. Reinforcement and spacing.
 - 8. Seam and joint construction.
 - 9. Penetrations through fire-rated and other partitions.
 - 10. Equipment installation based on equipment being used on Project.
 - 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
- C. Delegated-Design Submittal:
 1. Sheet metal thicknesses.
 2. Joint and seam construction and sealing.
 3. Reinforcement details and spacing.
 4. Materials, fabrication, assembly, and spacing of hangers and supports.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 2. Suspended ceiling components.
 3. Structural members to which duct will be attached.
 4. Size and location of initial access modules for acoustical tile.
 5. Penetrations of smoke barriers and fire-rated construction.
 6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Access panels.
- B. Welding certificates.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- D. Exhaust system shall comply with CMC Section 505 and 506. Hot gas exhaust ductwork shall conform to CMC Section 816, 817 and 818. Both systems shall comply also to NFPA 91.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated on the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corporation; Insulation Group.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - e. Or approved equal.
 - f. Maximum Thermal Conductivity:
 - 1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 1. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 2. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA Inc.
 - b. Armacell LLC.
 - c. Rubatex International, LLC
 - d. Or approved equal.
 - 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
 - 3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Insulation Pins and Washers:
 - 1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."



1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

3.2 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 3 inches.
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 7. Service: Indoor and outdoor.
 8. Service Temperature: Minus 40 to plus 200 deg F.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Water-Based Joint and Seam Sealant:
 1. Application Method: Brush on.

2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Base: Synthetic rubber resin.
 3. Solvent: Toluene and heptane.
 4. Solids Content: Minimum 60 percent.
 5. Shore A Hardness: Minimum 60.
 6. Water resistant.
 7. Mold and mildew resistant.
 8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 9. VOC: Maximum 395 g/L.
 10. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 11. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 12. Service: Indoor or outdoor.
 13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- E. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
 6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- G. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

3.3 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.



- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

3.4 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Hilti Corp.
 - 2. TOLCO; a brand of NIBCO INC.
 - 3. Unistrut Corporation; Tyco International, Ltd.
 - 4. Or approved equal.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by the Office of Statewide Health Planning and Development for the State of California.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

END OF SECTION 23 31 13



**SECTION 23 33 00
AIR DUCT ACCESSORIES**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies ductwork accessories such as volume control dampers, back-draft dampers, air turning vanes, flexible duct connections, duct access doors, duct test holes, combination fire smoke dampers and intake vents.

1.2 QUALITY ASSURANCE

- A. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
 - 1. NFPA 90A Installation of Air Conditioning and Ventilating Systems.
 - 2. SMACNA Low Pressure Duct Construction Standards.
 - 3. UL 33 Heat Responsive Links for Fire-Protection Service.
 - 4. UL 555 Fire Dampers and Ceiling Dampers.

1.3 ACTION SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 230000.
- B. Product Data: For each type of product.
- C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
- D. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - 1. Special fittings.
 - 2. Manual volume damper installations.
 - 3. Combination fire- and smoke-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - 4. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.



- B. Fusible Links: Furnish quantity equal to 10 percent of amount installed

PART 2 - PRODUCTS

2.1 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards, and as indicated.
- B. Fabricate splitter dampers of material same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
- C. Fabricate splitter dampers of single thickness sheet metal to streamline shape. Secure blade with continuous hinge or rod. Operate with minimum 1/4 inch diameter rod in self aligning, universal joint action flanged bushing with set screw.
- D. Fabricate single blade dampers for duct sizes to 12 x 48 inch.
- E. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- F. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
- G. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Where rod lengths exceed 30 inches provide regulator at both ends.
- H. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

2.2 REMOTE DAMPER OPERATORS

- A. Manufacturer:
 - 1. Young Regulator
 - 2. Approved Equal.
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Brass.
- D. Cable: Stainless steel.
- E. Wall-Box Mounting: Recessed.
- F. Wall-Box Cover Plate Material: Stainless Steel.

2.3 BACKDRAFT DAMPERS

- A. Manufactures shall be Ruskin, Greenheck or equal.
- B. Gravity back-draft dampers, size 18 x 18 inches or smaller, furnished with air moving equipment, may be air moving equipment manufacturer's standard construction.
- C. Fabricate multi-blade, parallel action gravity balanced back-draft dampers of extruded aluminum, with blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.



2.4 AIR TURNING VANES

- A. Multi-blade device with blades aligned in short dimension; blades shall have long trailing edges; steel or aluminum construction; with individually adjustable blades, mounting straps. Manufacturer shall be Aero/Dyne or equal (no known equal).

2.5 FLEXIBLE DUCT CONNECTIONS

- A. Manufacturer: Ventfrabrics or equal (no known equal).
- B. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards, and as indicated.
- C. UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd, approximately 6 inches wide, crimped into metal edging strip.
- D. Leaded vinyl sheet, minimum 0.55 inch thick, 0.87 lbs per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

2.6 DUCT ACCESS DOORS

- A. Manufacturers shall be Ventfrabrics, Ductmate, Pottorf Company or equal.
- B. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards and as indicated.
- C. Review locations prior to fabrication.
- D. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
- E. Access doors smaller than 12 inches square may be secured with sash locks.
- F. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.
- G. Access doors in round ducts shall be Ductmate, United Sheet Metal Type AR-W Peabody, Wind Spiromatic, Spiro-Duct or equal.
- H. Access doors with sheet metal screw fasteners are not acceptable.

2.7 DUCT TEST HOLES

- A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent test holes shall be factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.8 COMBINATION FIRE/SMOKE DAMPERS

- A. Manufacturer shall be Greenheck, Ruskin, Pottoff, or equal.
- B. Combination Smoke/Fire Dampers shall be furnished and installed at all locations shown on the plans and/or as described on the drawing details.
- C. Damper shall meet the requirements of NFPA 90A, 92A, and 92B and further shall be tested, rated and labeled in accordance with the latest edition on UL Standard 555 and 555S. Dampers shall have a UL555 fire rating of 1-1/2 hours and be of low leakage design qualified to UL 555S Leakage Class I.



- D. Damper actuator combination shall have a UL 555S elevated temperature rating of 350 degrees Fahrenheit minimum and shall be operational and dynamic rated to operate at maximum design airflow rate at its installed location.
- E. Damper shall be supplied with an appropriate actuator installed by the damper manufacturer at the time of damper fabrication. Damper actuator shall be electric type for 120 volt operation.
- F. Damper blades shall be 16 gauge galvanized steel 3 Vee type with three longitudinal grooves for reinforcement. Damper frame shall be galvanized steel formed into a structural hat channel shape with reinforced corners. Bearing shall be sintered bronze sleeve type rotating in extruded holes in the damper frame. Blade seals shall be silicone rubber designed to inflate and provide a tighter seal against leakage as pressure on either side of the damper increases. Jamb seals shall be stainless steel compression type with silicone rubber backing. Blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow in either direction or pressure on either side of the damper.
- G. Damper must be rated for mounting vertically (with blades running horizontally) or horizontally and be UL 555S rated for leakage and airflow in either direction through the damper.
- H. Damper shall be supplied with a 165 degree Fahrenheit fusible link. Provide access doors at either side of the combination smoke/fire damper for viewing of the fusible links.
- I. The specified combination smoke/fire damper shall meet the requirements for fire dampers, smoke dampers and combination fire smoke dampers established by:
- J. National Fire Protection **ASSOCIATION NFPA STANDARD 90A, 92A, 92B AND 101**
 - 1. Underwriters Laboratories Standard 555 Listing #R-13317
 - 2. Underwriters Laboratories Standard 555S Listing #R-13447
 - 3. California State Fire Marshall CSFM Fire Damper Listing #3225-0981:103
 - 4. California State Fire Marshall CSFM Leakage Smoke Damper Listing #3230-0981:104
- K. Smoke Detector will be provided by the electrical contractor to be compatible with the fire alarm system. Mechanical contractor shall install all duct-mounted smoke detectors. Electrical contractor shall connect smoke detector to smoke dampers and fire alarm panel. After installation is complete, electrical contractor shall test and verify that smoke detectors are active and functional.

END OF SECTION 23 33 00



**SECTION 23 34 23
HVAC POWER VENTILATORS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Centrifugal Roof Ventilators

1.2 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevations.
- B. Operating Limits: Classify according to AMCA 99.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set for each belt-driven unit.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.7 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Greenheck
 - 2. Loren Cook
 - 3. Twin City Fans
- B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base



with venturi inlet cone.

- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. Belt Drives:
 - 1. Resiliently mounted to housing.
 - 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 5. Fan and motor isolated from exhaust airstream.
- E. Accessories:
 - 1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 - 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 - 3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
- F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
 - 1. Configuration: Self-flashing without a cant strip, with mounting flange.
 - 2. Overall Height: 8 inches.
 - 3. Sound Curb: Curb with sound-absorbing insulation.
 - 4. Pitch Mounting: Manufacture curb for roof slope.
 - 5. Metal Liner: Galvanized steel.
- G. Provide with VariGreen ECM

2.2 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 NOT APPLICABLE

END OF SECTION 23 34 23

**SECTION 23 36 00
AIR TERMINAL UNITS**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies pressure independent variable air volume boxes, hot water reheat coils and factory furnished bottom access door and controlled by Building Management System (BMS) direct digital control system.

1.2 QUALITY ASSURANCE

- A. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
 - 1. NFPA 90A Installation of Air Conditioning and Ventilation Systems.
 - 2. UL 181 Factory-Made Air Ducts and Connectors.
- B. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.
 - 1. Air terminals shall be certified under ARI Standard 880-94 Certification Program and carry the ARI Seal.

1.3 SUBMITTALS

- A. Submit the following under provisions of Section 23 00 00.
- B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.
 - 1. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate air flow, static pressure, and NC designation, computer generated hot water reheat coil selections meeting design conditions indicated on plans.
 - 2. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of one to 4 inch wg.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Size and location of initial access modules for acoustic tile.
 - 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.
 - 1. Submit operation and maintenance data under provisions of Section 23 00 00.
 - 2. Include the following:
 - a. Instructions for resetting minimum and maximum air volumes.
 - b. Instructions for adjusting software set points.

PART 2 - PRODUCTS

2.1 AIR TERMINAL UNITS

- A. Manufacturers shall be Titus, Krueger, Price or Envirotec
- B. Ceiling mounted variable air volume (VAV) supply air control terminals for connection to low

pressure duct, central air systems, with variable volume controls and hot water heating coils as indicated on Drawings. Identify each airflow unit with clearly marked identification label and airflow indicator. Label shall include unit nominal air flow, maximum factory set air flow, minimum factory set air flow, and coil type. Coordinate with direct digital control system manufacturer for installation of VAV box controls.

2.2 VOLUME DAMPER

- A. Locate air volume damper and cross-flow airflow measuring device inside unit casing. Construct from extruded aluminum or 20 gage galvanized steel components. Damper shaft shall rotate in a self-lubricating bearing. Nylon bearings are not acceptable.
- B. Damper shall incorporate a mechanical stop to prevent over-stroking.
- C. Mount manually operated damper quadrant or automatic damper operator, and automatic flow control assembly externally or provide access doors.
- D. Externally mounted electric actuator shall position damper normally open as indicated.

2.3 HEATING COILS

- A. Hot Water Heating Coil: 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 300 psi with minimum burst pressure of 2000 psi at ambient temperature, factory installed.
- B. Fins shall be rippled and corrugated heavy gauge aluminum, mechanically bonded to the tubes.
- C. Tubes shall be copper with aluminum wall thickness of 0.016" with male solder header connections.
- D. Coil shall be enclosed in a minimum 20 gauge steel casing with slip and drive construction for attachment to metal ductwork. Coils shall be factory installed on the terminal discharge.
- E. Capacity, number of rows and circuits: As scheduled on Drawings.

2.4 WIRING

- A. Mount electrical components in control box with removable cover. Incorporate single point electrical connection to power source. Provide toggle disconnect switch and 120 volt to 24 volt transformer in each air terminal control box. Refer to Division 26 for additional requirements.

2.5 CONTROLS

- A. Automatic Damper Operator: Electric Actuator: 24 volt with high limit.
- B. Coordinate with direct digital control system manufacturer for installation of controls.

2.6 TESTS

- A. Provide testing of units under provisions.
- B. Test run volume dampers and controls. Check sequence of operation and air flow limits at factory prior to shipment.
- C. Base performance on tests conducted in accordance with ADC 1062.
- D. Maximum Casing Leakage: 10-cfm at 1.5 inch inlet static pressure.
- E. Maximum Damper Leakage: 5-cfm at 1.5 inch inlet static pressure.

PART 3 - EXECUTION

3.1 NOT APPLICABLE

END OF SECTION 23 36 00



**SECTION 23 52 16
CONDENSING BOILERS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes gas-fired, water-tube condensing boilers, trim, and accessories for generating hot water.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For boiler, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Source quality-control reports.
- C. Field quality-control reports.
- D. Sample Warranty: For special warranty.
- E. Manufacturer Start-up report
- F. Other Informational Submittals:
 - 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Water-Tube Condensing Boilers: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired



Boilers - Minimum Efficiency Requirements."

- D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N.
- E. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- F. Mounting Base: For securing boiler to concrete base.

2.2 WATER-TUBE CONDENSING BOILERS

- A. Manufacturers:
 - 1. Raypak
 - 2. Parker Boiler
 - 3. RBI
- B. Description: Factory-fabricated, -assembled, and -tested, copper-finned, water-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water-heating service only.
- C. Heat Exchanger: Finned-copper primary and stainless-steel secondary heat exchangers.
- D. Combustion Chamber: Stainless steel, sealed.
- E. Burner: Natural gas, forced draft drawing from gas premixing valve.
- F. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
 - 1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- H. Ignition: Silicone carbide hot-surface ignition that includes flame safety supervision and 100 percent main-valve shutoff.
- I. Integral Circulator: Cast-iron body and stainless-steel impeller sized for minimum flow required in heat exchanger.
- J. Casing:
 - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
 - 2. Control Compartment Enclosures: NEMA 250, Type 1A.
 - 3. Finish: Textured epoxy.
 - 4. Insulation: Minimum **2-inch** thick, mineral-fiber insulation surrounding the heat exchanger.
 - 5. Combustion-Air Connections: Inlet and vent duct collars.
- K. Capacities and Characteristics: See schedule on plans.

2.3 TRIM

- A. Include devices sized to comply with ASME B31.9.
- B. Safety Relief Valve: ASME rated.
- C. Pressure and Temperature Gage: Minimum 3-1/2-inch diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.
- D. Boiler Air Vent: Automatic.
- E. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- F. Circulation Pump: Nonoverloading, in-line pump with split-capacitor motor having thermal-overload



protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.4 CONTROLS

- A. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
 - 1. Hardwired Points or communications interface:
 - a. Monitoring: On/off status, common trouble alarm and low-water-level alarm.
 - b. Control: On/off operation, hot-water-supply temperature set-point adjustment.
 - 2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

2.5 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
 - 1. House in NEMA 250, Type 1 enclosure.
 - 2. Wiring shall be numbered and color coded to match wiring diagram.
 - 3. Install factory wiring outside of an enclosure in a metal raceway.
 - 4. Provide each motor with overcurrent protection.

2.6 VENTING KITS

- A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.
- B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.7 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.
- C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 NOT APPLICABLE

END OF SECTION 23 52 16



**SECTION 23 74 13
CUSTOM AIR HANDLING UNITS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes central station air handling units.
- B. Related Sections:
 - 1. Section 23 00 00 "General Mechanical Requirements"
 - 2. Section 23 05 13 "Common Motor Requirements"
 - 3. Section 23 05 14 "Variable Frequency Motor"
 - 4. Section 23 31 13 "Metal Ducts"
 - 5. Section 23 33 00 "Air Duct Accessories."

1.2 ACTION SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware, or accessory complies with the requirement of this particular specification section.
 - 1. The manufacturer shall resubmit this specification section showing compliance with each respective paragraphs and specified items and features.
 - 2. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
 - 3. Individual or partial submittals are not acceptable and will be returned without review.
- B. Submittals:
 - 1. Manufacturer shall provide the following information with each shop drawing/product data submission:
 - a. All electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations.
 - b. Each component of the unit shall be identified. Mechanical specifications describing construction, components, and options shall be provided for the unit and all accessories. All performance data, including capacities and airside and waterside pressure drops, for components.
 - c. Fan curves shall be provided for fans with the design operating points indicated. Data shall be corrected to actual operating conditions, temperatures, and altitudes.
 - d. A filter schedule must be provided for each air handling unit supplied by the air handling unit manufacturer. Schedule shall detail unit tag, unit size, corresponding filter section location within the AHU, filter arrangement (e.g. angled/flat), filter depth, filter type (e.g. pleated media), MERV rating, and filter quantity and size.
 - e. A schedule detailing necessary trap height shall be provided for each air handling unit. Schedule shall detail unit tag, unit size, appropriate trap schematic with recommended trap dimensions, and unit supplied base rail height. Contractor shall be responsible for additional trap height required for trapping and insulation beyond the unit supplied base rail height by adequate housekeeping pad.
 - f. An electrical MCA - MOP schedule shall be provided for each electrical circuit to which field-power must be supplied. Schedule to detail unit tag, circuit description, voltage/phase/hertz, Minimum Circuit Ampacity (MCA), and calculated Maximum Overcurrent Protection (MOP).
 - g. Variable frequency drive (VFD) and motor data.
 - h. Sound Test for the AHU in accordance with AMCA Standard 300-96, Reverberant Room Method for sound testing of fans, and where relevant, AHRI Standard 260-01, Sound Ratings of Ducted Air Moving and Conditioning Equipment.
 - i. Airflow measuring device performance ratings in accordance with AMCA 611.
 - j. Static pressure profiles by component section.
 - k. Casing leakage rate at +/- 10"/ [12"] w.g., specified in terms of percentage of design airflow.
 - l. Panel deflection data.



- D. Unit shall be shipped in a shrink-wrap or stretch-wrap to protect unit from in-transit rain and debris per ASHRAE 62.1 recommendations.
- E. Installing contractor shall be responsible for storing AHU in a clean, dry place and. Contractor shall protect units from weather, construction traffic, dust, and debris.
- F. Handle unit and componenets carefully to avoid damage to components, enclosures, and finish Protect, pack, and secure controls devices, electronic equipment, loose-shipped devices, electronic or pneumatic devices, and variable frequency devices.

1.7 WARRANTY

- A. Manufacturer shall provide, at no additional cost, a standard parts warranty that covers a period of one year from unit start-up or 18 months from shipment, whichever occurs first. This warrants that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins.
- B. Warranty shall cover air handling unit and accessories, excluding routine maintenance parts such as filters and belts.
- C. Contractor shall provide a Labor Warranty that covers a period of one year from unit start-up or 18 months from shipment, whichever occurs first.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Temtrol
 - 2. Energy Labs
 - 3. Haakon.

2.2 MANUFACTURED UNIT

- A. Manufacturer shall provide outdoor, rooftop, integral base frame unit to support and raise all sections of the unit for proper trapping. Unit base frames not constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel. Unit base height to be included in trap

2.3 UNIT BASE

- A. Unit base shall be fabricated from ASTM A36 welded structural steel channel or tubular steel. Formed bases are not acceptable. Bases shall be sized as a function of air handling length as follows:

Channel Construction:

Unit Length	Minimum Channel Size	Weight/Foot
Up to 10 feet	4" x 1-5/8"	5.4 lbs/ft
11 to 20 feet	6" x 2"	8.2 lbs/ft
21 to 30 feet	8" x 2-1/4"	11.5 lbs/ft
31 to 40 feet	10" x 2-3/5"	15.3 lbs/ft
41 to 50 feet	12" x 3"	20.7 lbs/ft

Tubular Steel Construction:

Unit Length x Width	Minimum Tube Size
Up to 16 feet x 97" wide	4" x 2"
Up to 20 feet x 139" wide	5" x 2"
Up 25 feet x 181" Wide	6" x 2"
Up to 25 feet x 300" wide	8" x 2"



- B. Frame members shall be sized to limit deflection to $L/200$, minimizing deflection during rigging and installation. Intermediate tubular steel or C-Channel cross members are fully welded and located at lifting points and as needed to support internal components such as coils, fans, etc. Removable or welded lifting lugs shall be added to the perimeter channel along the longest length of the unit.
- C. Structural floor panels shall be 14-gauge or thicker bright galvanized steel with deep flanges and a maximum panel width of 24" for exceptional rigidity. Flooring shall be welded or screwed to unit frame. All panels shall be fully caulked with a high performance polymer sealant. Sealant shall be low VOC and be free of silicone and isocyanates. Section splits shall be supplied with an upturned bolted flange and u-clip for field connections.
- D. All access section floors shall be covered with 0.125" thick, #3003 aluminum tread plate sheets.
- E. The entire floor and frame shall be foamed with a 2-part polyurethane foam. Minimum foam thickness shall be 2" underneath the base surface and $\frac{1}{2}$ " on flanges and angles. Provide 20 gauge galvanized steel liner.

2.4 UNIT CASING

- A. Housing: The unit housing side and roof panels shall be constructed of 16-gauge galvanized steel, and shall utilize a standing seam modular panel type construction. All floors shall be constructed of 14-gauge or thicker galvanized steel. The panels shall be caulked and attached to each other, to the roof, and to the floor. All panels shall be removable. All seams shall be sealed with an acrylic latex sealant prior to assembling the panels and after completion of the assembly. All floor openings shall have 12 gauge galvanized steel-framed flange around the entire perimeter of opening for duct connection. The casing structure shall incorporate insulating thermal breaks as required so that, when fully assembled, there exists no path of continuous unbroken metal to metal conduction from inner to outer surfaces.
- B. Minimum sound transmission loss (STL) through unit panels shall be as follows:

OCTAVE BAND CENTER FREQUENCY

125	250	500	1K	2K	4K
25	29	36	42	47	48

- C. Outdoor units shall have roofs with a minimum of $\frac{1}{4}$ " per foot slope to insure no standing water.
- D. Insulation and Interior Liner: Insulation shall be 2" thick, 3 lbs per cubic foot density, neoprene coated fiberglass to cover all walls and ceilings. This insulation shall meet NFPA-90A smoke and flame spread requirements. All floors shall be insulated from below using minimum 1" thick foam to insure that the entire under surface of the floor is insulated. There shall be no raw edges of insulation exposed to the air stream. The entire interior of all units shall be lined with minimum 20 gauge bright galvanized steel liner. The interior liner of the fan sections, inlet plenum sections, and discharge plenum sections shall be perforated and the remaining shall be steel.
- E. Paint Finish: After final assembly the unit exterior shall be coated with an industrial grade high solids polyurethane paint. In addition, all fan bases, springs and structural steel supports shall be coated with the same finish. The paint system shall meet A1STM B Salt spray test for 5000 hours in a 5% solution. Paint shall be applied in an environmentally sealed paint chamber specifically designed for paint application. Manufacturers without paint booth facilities shall use pre-painted 16 gage steel that meets ASTM B117 5000 hr salt spray testing.

2.5 ACCESS DOORS

- A. All access doors shall be hinged, double wall, and insulated with the same material as the unit casing. Person-size access doors shall be provided in all sections requiring access for maintenance or service. The frame shall be constructed of extruded aluminum, fully welded at the corners with an anodized finish. The doors shall utilize a dual gasket seal system. All hardware provided shall be non-corrosive and all hinges and latches shall be adjustable with nuts and bolts. Access door must not leak more than 25 CFM @ 6" static pressure.



- B. Door hinges and latches shall be easily adjustable, without the use of shims or special tools, to allow for a tight seal between the door and the doorframe as the gasketing material compresses over time.
- C. All doors shall open against pressure to ensure an airtight seal and to prevent a safety hazard. The door hinge design shall allow for field reversing of door swing and doors shall be easily removable. Provide door detail drawing with submittal package.
- D. Doors entering into any section of the air handler that contains rotating fans shall be provided with a door interlock safety switch to de-energize the fan motor upon opening. All doors must swing against the air pressure (i.e., positive pressure plenum doors must swing in).
- E. All access doors shall include an 8" x 12" wire reinforced UV protected glass view window.
- F. All access doors shall include instrument test holes to enable measurement of pressure drop across unit components. Test ports shall have a removable cover that completely seals the door penetration when testing and balancing is not being conducted.
- G. Door latches and handles shall be constructed of corrosion-resistant material. Corrosion-resistant and UV-resistant material shall be used for outdoor applications.

2.6 FANS

- A. Supply and return fans shall be direct drive Arrangement #4 plenum fans. Fan wheels shall be aluminum with aluminum extruded airfoil blades. The fan inlet shall be isolated from the cabinet by means of a neoprene-coated flexible connection. Plenum fans shall be provided with spring-style thrust restraints.
- B. Each fan shall be sized to perform as indicated on the equipment schedule. The wheel diameter shall not be less than that shown on the equipment schedule. The fan shall be constructed to AMCA Standards for the Class Rating as indicated on the Equipment Schedule.
- C. Fan Base, Spring Isolation, and Support Framing: Mount fan and motor on an internal, fully welded, rigid steel base. Base shall be free-floating at all four corners on spring type isolators with earthquake restraints. The fan assembly shall be isolated from the cabinet by steel springs with minimum deflection of 2.0" or as indicated on schedules. The spring isolators shall be mounted to structural steel members. All isolators shall be rated for zone 4 (Verify) seismic requirements. The spring isolators shall be mounted on a waffle pad for vibration isolation.
- D. Balancing: The fan shaft shall be sized not to exceed 75% of the first critical speed for maximum RPM of Class specified. The critical speed will refer to the top of the speed range of the fans' AMCA class. The lateral static deflection shall not exceed 0.003" per foot of the length of the shaft. Fans shall be balanced to ISO standard G6.3. A copy of the balance test data for this project showing calculations for deflection and critical speed of the shaft and wheel assembly shall be submitted to the engineer and a copy forwarded to the Owner.
- E. Plenum fan assembly must have an enclosed safety screen built per OSHA Standards. Fans shall have OSHA approve inlet screens.
- F. Hoist Rail: Provide I beam hoist rail above fan section access doors to remove motors 10 hp and above. An optional extendable arm to be provided to transport the motor to the unit exterior.
- G. Provide factory mounted gravity backdraft dampers for all fans.
- H. Fan bearings are to have a minimum average life (L50) of 200,000 hours per ANSI/ABMA 9 or ANSI/ABMA 11 for ball bearings and roller bearings, respectively.
- I. All fan bearings shall have grease fittings extended to an accessible location.
- J. Fan Airflow Measurement:
 - 1. Supply air and return air shall be measured by a Flow Track sensor (piezo ring) and a Veltron 2500+ Air Flow Transmitter or Engineer approved equal. The flow measuring station shall not obstruct the inlet of the fan and shall have no effect on fan performance (flow or static) or sound power levels.
 - 2. All transmitters shall be mounted outside the unit for access or shipped loose for field mounting by controls contractor. Interface to BMS is by others.



2.7 MOTORS AND DRIVES

- A. All motors and drives shall be factory-installed and run tested.
- B. Refer to Specification Section 230513 COMMON MOTOR REQUIREMENTS for additional requirements.
- C. All motors and drives shall be factory-installed and run tested. Motors shall be premium efficiency, TEFC, NEMA frame, ball bearing type motors.
- D. Fan motors shall be factory wired to an external VFD with flexible conduit of adequate length so that it will not have any effect on the vibration isolation.
- E. Provide motor shaft grounding for all motors connected to VFDs.

2.8 COILS

- A. All coils shall be of the plate fin extended surface type. Tubes shall be 5/8" outside diameter seamless copper with a 0.020" minimum wall thickness. Each coil shall have individually replaceable return bends of 0.025" wall thickness on both sides of the coil. Coils incorporating a "hairpin" type design are not acceptable. Tubes shall be expanded into the fin collars to provide a permanent mechanical bond.
- B. The secondary surface shall be formed of 0.075" aluminum fins and shall be spaced not closer than 10 fins per inch with integral spacing collars that cover the tube surface. Headers shall be non-ferrous seamless copper, outside the air stream and provided with brazed copper male pipe connections. Drain and vent tubes shall be extended to the exterior of the air handling unit.
- C. All coils shall have counter flow construction. Provide left or right hand coil connections as shown and coordinated with the bid documents and submitted for review. The use of internal restrictive devices to obtain turbulent flow will not be accepted.
- D. All coils shall be provided with corrosion-resistant coating. Coating shall be resistant to exposure to UV lighting, where applicable.
- E. Coil casings shall be of minimum 16-gauge, 316 stainless steel with double-formed 1-1/4" stacking flanges and 3/4" flanges on the side plates. All other coil casing shall be of 16-gauge galvanized steel. Flanged tube sheets shall have extruded tube holes to prevent raw edges of tube sheets cut into copper tubes because of thermal expansion of tubes in tube holes. Tube holes with raw sheet metal edges are not acceptable. Reinforcing shall be furnished so that the unsupported length is not over 60". All coil assemblies shall be tested under water at 300 psi and rated for 150-psi working pressure. Headers are to be located inside the cabinet casing with only the pipe connections extending through the casing. All sides of coils shall be carefully blanked off with the same materials used for the coil casings, to ensure all air passes through the coil.
- F. Intermediate condensate pans are to be furnished on multiple coil units and single coils greater than 48" high. The pans shall be 16Ga. 316 stainless steel and drain to the main drain pan through copper downspouts.
- G. All water coils shall be rated in accordance with ARI Standard 410. The air handling unit manufacturer, for the purpose of sole source responsibility, shall manufacture all coils supplied for the air handlers.

H. All coils at exterior AHU locations to have epoxy coating.

2.9 PRIMARY DRAIN PANS

- A. The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in three planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements.
- B. Cooling coil section shall be provided with a 16 gauge, 316 stainless steel drain pan. The drain pan shall be insulated beneath the surface with 2.0", 2-part polyurethane insulation to prevent condensation under the drain pan.
- C. Coil support members inside the drain pan shall be 10 gauge, #316 stainless steel.



- D. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.
- E. All drain pan threaded connections shall be visible external to the unit and shall discharge at the side of the unit.
- F. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2-inch beyond the base to ensure adequate room for field piping of condensate traps.
- G. Provide left or right hand coil connections as shown and coordinated with the bid documents and submitted for review.

2.10 FILTERS

- A. Filter sections shall be fabricated as part of the air-handling unit. Filters shall be arranged for upstream loading as shown on the drawings. Provide filter-holding frames to accommodate scheduled filters. Filter frames shall be 16 Ga. galvanized steel and shall be fully welded to reduce leakage of air through corners. Internal blank-offs shall be provided by the air handling unit manufacturer as required to prevent air bypass around the filters.
- B. All air filters shall be State Fire Marshal approved and listed type. Preformed filters having combustible framing shall be tested as a complete assembly. Air filters in all occupancies shall be Class 2 or better, as shown in the State Fire Marshal listing. Air filters shall be accessible for cleaning or replacement.
- C. Pre-filters shall be 2" deep, 30% efficient, MERV 8 extended surface pleated filters. Frames shall be recyclable, moisture resistant clay coated board with diagonal and horizontal support members on the upstream and downstream sides, and shall have interlocking corner tabs.
- D. Final filters shall be 12" deep, 95% efficient, MERV-14 final filters Minipleat, extended media area, totally rigid and disposable. Air filters shall be Aerostar by Filtration Group or equal, and shall have average efficiency of not less than 95% when tested in accordance with ASHRAE 52-76 test standard.
- E. Filters shall be of the quantities and sizes as indicated on the drawings.
- F. Provide one set of additional startup pre-filters.
- G. Provide factory installed Setra 267 digital filter gauge with LCD display or Engineer approved equal at each filter bank.
 - 1. Gauge shall be complete with static pressure tips, hardware and fittings.
 - 2. Enclose the gauge in a protective sheet metal box with a hinged inspection door. Paint to match unit.
 - 3. Provide IP65/NEMA 4 rated enclosure. All transmitters shall be mounted outside the unit for access.

2.11 ECONOMIZER, MINIMUM OSA, RETURN AND RELIEF AIR DAMPER SECTION

- A. Economizer section shall include dampers for return air, fresh air and exhaust air. Dampers shall be opposed blade type. Dampers shall be sized for not greater than 1200 fpm face velocity based upon gross damper area. Furnish full height 24" wide access doors for damper and linkage service.
- B. Dampers shall be supplied with low leak extruded aluminum airfoil blades. Blades shall be supplied with rubber edge seals and stainless steel arc end seals. Rubber edge seals shall be backed by the damper blade to assure a positive seal in the closed position. Dampers shall be provided with nylon bearings within extruded openings. Damper leakage shall not exceed 6 CFM/ft² at 5.0" of static pressure. Leakage testing shall be in accordance with AMCA standard 500 figure 5.5. Test results must be from independent testing laboratory.
- C. Provide louvers for outside air and exhaust air for units located outdoors. OSA Louvers shall be sized for a maximum face velocity of 750 fpm and exhaust air louvers shall be sized for a maximum face velocity of 800 fpm based on gross louver area. Louvers shall have zero water penetration at 600-ft/min air velocity. Maximum louver pressure drop shall be 0.03" in w. g. at 700 ft/min. Provide test results from independent testing laboratory. Test must be conducted in accordance to AMCA Standard 500 figure 5.5. Louver water carry over must be less than 0.01 oz/ft² at 1100 ft/min of free louver area. Test must be



conducted by independent testing laboratory per AMCA 500-89 figure 5.6. Hoods in lieu of louvers are not acceptable.

- D. Damper shall be heavy duty type.

2.12 MINIMUM OUTSIDE AIR DAMPER AND AIR FLOW MONITORING SECTION

- A. The minimum OSA dampers shall have individual EBTRON, Inc "Gold Series" Model GTC116-PC airflow measuring devices or equal.
- B. Each ATMD shall consist of one or more sensor probes and a single, remotely mounted, 32 bit microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor nodes contained in one or more probe assemblies per measurement location.
- C. Probes shall be constructed of extruded, gold anodized, 6063 aluminum tubes. All internal wires within the tube shall be Kynar coated. PVC insulated conductors are not acceptable.
- D. Each sensor node shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
- E. Thermistors shall be mounted in the sensor node using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment. Thermistors leads shall not be fastened to the thermistor semiconductor substrate by weld or solder connections. Manufacturer shall provide UL listed, FEP jacketed, plenum rated cable(s) between sensor probes and the remote transmitter.
- F. The airflow rate at each sensor node shall be equally weighted and arithmetically averaged by the transmitter prior to output. All integrated circuitry shall be temperature rated as 'industrial-grade'. Submissions containing 'commercial-grade' integrated circuitry are not acceptable.
- G. Each sensing node shall be individually wind tunnel calibrated at 16 points to NIST traceable airflow standards. Airflow accuracy shall be +/-2% of Reading over the entire operating airflow range of not less than 0 to 5,000 fpm (25.4 m/s).
- H. The transmitter shall have an integral LCD display capable of simultaneously displaying airflow and temperature. Individual airflow and temperature readings of each independent sensor node shall be accessible. The transmitter shall be capable of field configuration and diagnostics using an on-board pushbutton interface and LCD display.
- I. The transmitter shall have two isolated and fused analog output signals and one RS-485 network connection. One analog output shall be for velocity and the other for a temperature output or LEED alarm function. All transmitters shall have integral self-diagnostics.
- J. Other than the thermistor sensors, no other electronic components shall be located at the sensing node. Signal processing circuitry on or in the sensor probe shall not be acceptable.
- K. Devices using chip-in-glass, epoxy-coated or diode-case chip thermistors are not acceptable.
- L. Devices with RJ-45 connections exposed to the environment or having electronic circuitry mounted in or at the sensor node are not acceptable.
- M. Pitot tubes and arrays are not acceptable.
- N. Vortex shedding devices are not acceptable.
- O. The transmitter shall be mounted outside the unit for access.

2.13 VARIABLE FREQUENCY DRIVES (VFDS)

- A. Refer to Specification Section 230514 VARIABLE FREQUENCY MOTOR CONTROLLERS for additional requirements.
- B. All standard and optional features, such as VFD bypass or redundant VFD's, shall be included within the VFD enclosure. The VFDs shall be UL listed. The listing shall allow mounting in plenum or other air handling compartments.
- C. For redundant VFD's, provide control wiring and control circuitry to manually (or automatically) transfer from main VFD's to redundant VFD when main drive has faulted.
- D. Each VFD shall have its own means of disconnect either by circuit breaker or fused disconnect.



- E. VFD's shall be mounted on (or in) the air handling unit in single NEMA 3R hinged enclosure.
 - 1. VFD input and output power shall be installed in separate conduits.
- F. Provide separate motor overload panel with individual motor overloads and factory wired to the motors with a single point of connection for the VFD.
- G. An appropriate means of VFD cooling shall be provided for recessed mounted or NEMA 3R Rated enclosures.

2.14 UNIT MOUNTED CONTROLS

- A. All controls shall be field installed by the installing temperature controls contractor and coordinated with the new building automation system. These controls shall include all damper actuators, temperature sensors, pressure sensors, air flow measuring sensors, filter switches, smoke and fire detectors as indicated on the control drawings.
- B. Electric and electronic controls shall be wired to a terminal block in a sheet metal enclosure located at a common location mounted on the air handling unit. All pressure sensing controls shall be piped to a common point on the unit with 1/4" compression fittings.
- C. Wiring for chilled water and hot water control valves shall be field supplied by the installing contractor. Control valve wiring shall be extended to an external junction box located near the coil connections with the final wiring connection done by the temperature controls contractor. All control valves and piping specialties shall be provided by the temperature controls contractor and/or piping contractor.
- D. Unit shall include factory installed conduit between sections and split for controls ready construction. If the unit requires splitting; junction boxes shall be furnished on each section to allow the control contractor to make final connections in the field. Wiring shall be clearly labeled to allow ease in final interconnections.
- E. All controls shall be supplied and installed by the Division 230900 temperature controls contractor. All wiring shall be performed in a U.L. 508 listed shop.
- F. Electrical contractor shall bring separate 120/1/60 power for controls.

2.15 ELECTRICAL REQUIREMENTS

- A. All wiring shall be performed in a UL 508 listed shop. Provide single source power panels (SSPP's) that are constructed according to CEC regulations and carry a U.L.508 listing and label. The panel shall include a non-fused main disconnect switch covering all fans in each unit, VFD's for variable volume units, and any necessary transformers, Hand-Off-Auto switches, relays and pilot lights for complete operation of the fans in the unit. The single source power panels shall be factory wired to all factory furnished devices such as motors and interlocks.
- B. The air handling unit manufacturer, for the purpose of sole source responsibility, shall manufacture all electrical panel assemblies supplied for the air handlers. The air handling unit manufacturer shall be a U.L. 508 listed panel shop.
- C. The main control panel shall have access door(s) for direct access to the controls. The panel shall be NEMA type 3R (rainproof) and shall contain a single externally operated, non-fused disconnect, suitable for copper wire up to and including 3" conduit. The electrical contractor shall bring separate 460/3/60 power to the single source power panel.
- D. All wiring shall be run in EMT conduit (or flexible when connecting to a motor). Raceways are not acceptable.
- E. Provide fluorescent marine style lights in each access section wired to a common weatherproof switch with 60 minute timer mounted adjacent to the supply fan access door. 120V GFI duplex service receptacles shall be installed and wired with the lighting circuit and located at each fan compartment. The electrical contractor shall bring separate 120/1/60 power to this circuit connected at the supply fan GFI outlet.

2.16 UNIT SOUND POWER LEVELS

- A. Provide sound power level data for the unit that will be supplied.



2.17 SOUND POWER AND PERFORMANCE CERTIFICATION

- A. Manufacturer shall perform sound test on one selected unit that will be provided for this project in accordance with AMCA Standard 300-96 Reverberant Room Method for sound testing of fans, and AMCA Standard 210, Laboratory Methods of Testing Fans for rating. All testing shall be conducted in a laboratory AMCA certified for both sound and performance.
- B. The sound power data shall be submitted for review. Sound power data shall be provided at the supply and return connection in addition to radiated sound power from the cabinet. Raw fan sound power data shall be derived from tests done in accordance with AMCA Standard 300-96. Attenuation assumed for the cabinet configuration, type of insulation, opening locations and sizes, etc., shall be verified through actual test measurements. Provide copy of all test reports.
- C. The manufacturer shall notify the Owner's Representative a minimum of ten (10) days prior to test as to the location and date of the sound test for witness. All costs shall be provided by the equipment manufacturer.
- D. If sound test indicates noise levels above specified levels, the manufacturer shall take corrective measures to reduce the sound to specified levels. Any modifications that are necessary to meet scheduled sound levels shall be applied to all units. Test results shall be submitted to the Owner's Representative for review prior to shipment of any equipment.

2.18 AIR PERFORMANCE TESTING

- A. The manufacturer shall perform an air performance test on one selected unit in accordance to AMCA 210-85/ANSI 51-1985 "Standard for Laboratory Measurement of Airflow".
- B. Submit air handling unit air performance data to Owner's Representative for review.
- C. The manufacturer shall notify the Owner's Representative a minimum of ten (10) days prior to test as to the location and date of the air performance test for witness. All costs shall be provided by the equipment manufacturer.

2.19 ACCESSORIES

- A. Contractor shall provide roof curb.
- B. Roof curb shall be constructed of 12 gauge galvanized steel and manufactured by M.W. Sausse Model RMLS non-isolated unit or equal.

PART 3 - EXECUTION

3.1 NOT APPLICABLE

END OF SECTION 23 74 13



SECTION 23 74 16
PACKAGED , ROOFTOP AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes packaged, large-capacity, rooftop air conditioning units (RTUs) with the following components and accessories:
 - 1. Casings.
 - 2. Fans.
 - 3. Motors.
 - 4. Coils.
 - 5. Refrigerant circuit components.
 - 6. Air filtration.
 - 7. Gas furnaces.
 - 8. Dampers.
 - 9. Electrical power connections.
 - 10. Controls.
 - 11. Accessories
 - 12. Roof curbs.

1.2 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electronically commutated motor.
- C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- D. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, large-capacity, rooftop air-conditioning units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- E. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- F. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.3 ACTION SUBMITTALS

- A. The manufacturer, contractor or supplier shall include a written statement that the submitted equipment, hardware, or accessory complies with the requirement of this particular specification section.
 - 1. The manufacturer shall resubmit this specification section showing compliance with each respective paragraphs and specified items and features.
 - 2. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
 - 3. Individual or partial submittals are not acceptable and will be returned without review.
- B. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
 - 1. Factory selection calculations for each antimicrobial ultraviolet lamp installation.
- C. Shop Drawings:
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.



2. Include diagrams for power, signal, and control wiring.
- D. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 3. Seismic Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Structural members to which RTUs will be attached.
 2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.
 3. Roof curbs and flashing.
 4. Roof curb mounting details.
- B. Seismic Qualification Data: Certificates, for RTUs, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 4. Restraint of internal components, including fans, coils, and refrigeration components.
- C. Field quality-control reports.
- D. Startup service report.
- E. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fan Belts: One set for each belt-driven fan, where applicable..
 2. Filters: One set of filters for each unit.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of RTUs that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
 2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than ten years from date of Substantial Completion.
 3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.



4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.
5. Warranty Period for Antimicrobial Ultraviolet Lamp System: Lifetime with exception of lamps.
6. Warranty Period for Economizer Dampers and Assembly: .Not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. AHRI Compliance:
 1. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
 2. Comply with AHRI 270 for testing and rating sound performance for RTUs.
 3. Comply with AHRI 1060 for testing and rating performance for air-to-air exchanger.
 4. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.
- B. AMCA Compliance:
 1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
 2. Damper leakage tested in accordance with AMCA 500-D.
 3. Operating Limits: Classify according to AMCA 99.
- C. ASHRAE Compliance:
 1. Comply with ASHRAE 15 for refrigeration system safety.
 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. NFPA Compliance: Comply with NFPA 90A or NFPA 90B.
- F. UL Compliance: Comply with UL 1995.
- G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with the requirements, provide products by one of the following:
 1. Trane
 2. Carrier
 3. York
 4. Daikin

2.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer to design mounting and restraints for RTUs, including comprehensive engineering analysis.
 1. Design RTU supports to comply with seismic performance requirements.
- B. Seismic Performance: RTUs shall withstand the effects of earthquake motions determined according to ASCE 7.
 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified"

2.4 CASINGS

- A. Cabinet: Galvanized steel, phosphatized, and finished with paint coating certified at 1000 hours in salt spray test in compliance with ASTM B117.



- B. Cabinet top cover shall be one piece construction or where seams exist, it shall be double-hemmed and gasket-sealed.
- C. Access Panels: Water- and air-tight panels with handles shall provide access to filters, heating section, return air fan section, supply air fan section, evaporator coil section, and unit control section.
- D. Units base pan shall have a raised 1 1/8 inch high lip around the supply and return openings for water integrity.
- E. Insulation: Provide 1/2 inch thick fiberglass insulation with foil face on all exterior panels in contact with the return and conditioned air stream. All edges must be captured so that there is no insulation exposed in the air stream.
- F. Provide openings either on side of unit or through the base for power, control, condensate, and gas connections.
- G. The base of the units shall have rigging/lifting holes for crane maneuvering.
- H. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.5 FANS

- A. Supply-Air Fans: Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
 - 1. Direct-Driven Supply-Air Fans: Motor shall be resiliently mounted in the fan inlet.
 - 2. Belt-Driven Supply-Air Fans: Motors shall be installed on an adjustable fan base resiliently mounted in the casing.
- B. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated multispeed motors.
- C. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Section 23 05 48 "Vibration and Seismic Controls for HVAC" when fan-mounted frame and RTU-mounted frame are anchored to building structure.

2.6 MOTORS

- A. Comply with Section 23 05 13 "Common Motor Requirements for HVAC Equipment" and the requirements of this Article.
- B. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.7 COILS

- A. Supply-Air Refrigerant Coil:
 - 1. Aluminum plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
 - 2. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating, formed with pitch and drain connections complying with ASHRAE 62.
- B. Supply-Air Hydronic Heating Coil:
 - 1. Aluminum plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor and with air vent and drain.
- C. Hot-Gas Reheat Refrigerant Coil:
 - 1. Aluminum plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
 - 2. Suction-discharge bypass valve.
- D. All coils shall be provided with corrosion-resistant coating. Coating shall be resistant to exposure to UV lighting, where applicable. Cathodic epoxy type electro-disposition coating formulated for high edge build to plate fin and tube heat exchangers. Coating shall provide excellent resistance and durability to corrosive effects of alkalis, acids, alcohols, petroleum, seawater, salt air and corrosive environments.



2.8 AIR FILTRATION

- A. General: Each filter section shall be designed and constructed to house specific type of filter indicated on equipment schedule. Provide filters of type indicated on schedule. A hinged access door shall be provided on side of section. Internal blank-offs shall be provided to prevent air bypass around filters.
 - 1. Filters shall be standard, commercially available sizes.
 - 2. Only one size filter per unit is allowed.
 - 3. Minimum MERV Rating: 13 per ASHRAE 52.2
- B. Filter tracks in flat or cartridge filter sections: Filter tracks in flat or cartridge filter sections shall be upstream loaded Type 8 constructed from galvanized steel to ensure rigidity and tight tolerances. Tracks must be field adjustable without tools and designed to accept standard-size filters with one inch, 2-inch, or 4-inch widths.
- C. Filter tracks in angle filter sections: Filter tracks in angle filter sections shall be constructed from galvanized steel to ensure rigidity and tight tolerances. Angle filter sections shall be designed to hold 2-inch filters of standard sizes, arranged in horizontal V-formation.
- D. Bag or cartridge filter sections: Bag or cartridge filter sections shall be capable of accepting standard size 12-inch deep rigid media or bag filters. When bag/cartridge filters are installed in a positive pressure application, section shall be furnished with upstream service filter access and doors shall open inward against pressure for safety and leak integrity. For filters with lengths longer than 12 inches, additional plenum sections shall be furnished. Filter sizes shall be 24 by 24-inch or 12 by 24-inch only.

2.9 GAS FURNACES

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.
 - 1. CSA Approval: Designed and certified by and bearing label of CSA.
- B. Burners: Stainless steel.
 - 1. Fuel: Natural gas.
 - 2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
- C. Heat-Exchanger and Drain Pan: Stainless steel.

2.10 ANTIMICROBIAL ULTRAVIOLET LAMP SYSTEM

- A. Description: Lighting unit installation in rooftop unit with lamps, reflectors, remote water-resistant power supply and cable, and support brackets. Lamps emit 254 nm UV "C" (UVC) band. In metal housing with viewport arranged for and controlled to cycle on and off with cooling coil. Locate downstream of cooling coils and over condensate drain pans.

2.11 DAMPERS

- A. Outdoor- and Return-Air Mixing Dampers: Parallel blade galvanized-steel dampers mechanically fastened to cadmium plated or galvanized-steel operating rod in reinforced cabinet.
 - 1. Leakage Rate: Damper leakage shall not exceed 7 CFM/ft² at 1.0" of static pressure when tested in accordance with AMCA standard 500.
 - 2. Damper Reliability Testing: Comply with current version California Title 24, Part 6
 - 3. Damper Motor: Modulating with adjustable minimum position.
- B. Relief-Air Damper: Gravity actuated or motorized.

2.12 ELECTRICAL POWER CONNECTIONS

- A. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.13 CONTROLS

- A. Control of equipment and sequence of operation are specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC" and Section 23 09 93 "Sequence of Operation for HVAC Controls.
- B. Thermostat



1. Wall-mounted thermostat or sensor with the following features:
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
 - c. Fan-speed switch.
 - d. Automatic changeover.
 - e. Adjustable deadband.
 - f. Exposed set point.
 - g. Exposed indication.
 - h. Degree F indication.
 - i. Unoccupied-period-override push button with maximum 4-hour override.
 - j. Data entry and access port to input temperature set points, occupied and unoccupied periods, and output room temperature, supply-air temperature, operating mode, and status.
 - k. Occupied and unoccupied periods on seven day clock with a minimum of four programmable periods within 24 hours.
- C. Integral controller
 1. Unit shall be complete with low-voltage control circuit protected by a resettable circuit breaker on the 24-volt transformer side.
 2. Unit shall incorporate a lockout circuit which provides reset capability at the space thermostat or base unit should any of the following standard safety devices trip and shut off compressor:
 - a. Loss-of-charge/Low-pressure switch.
 - b. High-pressure switch.
 - c. Freeze-protection thermostat, evaporator coil. If any of the above safety devices trip, an LED (light-emitting diode) indicator shall flash a diagnostic code that indicates which safety switch has tripped.
 3. Unit shall incorporate "AUTO RESET" compressor over temperature, over current protection.
 4. Unit shall operate with conventional thermostat designs and have a low voltage terminal strip for easy hook-up.
 5. Unit control board shall have on-board diagnostics and fault code display.
 6. Standard controls shall include anti-short cycle and low voltage protection, and permit cooling operation down to 0 °F.
 7. Control board shall monitor each refrigerant safety switch independently.
 8. Control board shall retain last 5 fault codes in non-volatile memory, which will not be lost in the event of a power loss.
- D. Interface Requirements for HVAC Instrumentation and Control System:
 1. Interface relay for scheduled operation.
 2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
 3. Provide BACNET compatible interface for central HVAC control workstation for setpoint adjustment and system monitoring.
- E. Fault Detection: Provide Fault Detection and Diagnostics (FDD) system in accordance with Title 24.

2.14 ACCESSORIES

- A. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- B. Remote potentiometer to adjust minimum economizer damper position.
- C. Return-air bypass damper.
- D. Factory- or field-installed demand-controlled ventilation.
- E. Safeties:
 1. Smoke detector.
 2. Condensate overflow switch.
 3. Phase-loss protection.



- 4. High pressure control.
- 5. Gas furnace airflow-proving switch.
- F. Coil guards of painted, galvanized-steel wire.
- G. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.
- H. Vertical vent extensions to increase the separation between the outdoor-air intake and the flue-gas outlet.
- I. Door switches to disable heating or reset set point when open.
- J. Outdoor air intake weather hood.

2.15 ROOF CURBS

- A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
- B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 - 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C 1071, Type I or II.
 - b. Thickness: 1 inch
 - 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C 916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C 916, Type I.

PART 3 - EXECUTION

3.1 NOT APPLICABLE

END OF SECTION 23 74 16

**SECTION 23 81 26
SPLIT-SYSTEM AIR-CONDITIONERS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set(s) for each fan coil unit.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.7 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressor: Five year(s) from date of Substantial Completion.
 - b. For Parts: Five year(s) from date of Substantial Completion.



- c. For Labor: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - 1. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
 - 2. Fujitsu
 - 3. LG

2.2 INDOOR UNITS (5 TONS OR LESS)

- A. Wall-Mounted or Ceiling mounted, Evaporator-Fan Components:
 - 1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
 - 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
 - 3. Fan: Direct drive, centrifugal.
 - 4. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Enclosure Type: Motors shall be open drip proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.
 - d. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - e. Mount unit-mounted disconnect switches on exterior or interior of unit.
 - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 - 6. Condensate Drain Pans:
 - a. Provide external secondary drain pan.
 - b. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - c. Single-wall, stainless-steel sheet.
 - d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - 1) Minimum Connection Size: 3/4 inch.
 - 7. Air Filtration Section:
 - a. General Requirements for Air Filtration Section:
 - 1) Comply with NFPA 90A.
 - 2) Minimum Arrestance: According to ASHRAE 52.1 and MERV 13 according to ASHRAE 52.2.
 - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - b. Disposable Panel Filters:
 - 1) Factory-fabricated, viscous-coated, flat-panel type.
 - 2) Thickness: 1 inch.
 - 3) Arrestance according to ASHRAE 52.1: 80.
 - 4) Merv 13 according to ASHRAE 52.2: 8.



- 5) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
- 6) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

- A. Air-Cooled, Compressor-Condenser Components:
 1. Casing: Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked enamel finish on inside and outside. Access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components. Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.
 2. Compressor: Fully hermetic with oil system, operating oil charge, and motor. Internal overloads shall protect the compressor from over-temperature and over-current.
 - a. Compressor Type: Scroll.
 - b. Refrigerant Charge: R-410A.
 - c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.
 3. Fan: Direct drive propeller type, horizontal discharge, blow through configuration. Blades shall be statically and dynamically balanced with a PVC coated metal protective grille.
 4. Motor: NEMA rated class F suitable for operation in a refrigerant atmosphere. Totally enclosed single phase motor with class B insulation and permanently lubricated bearings. Motor shall be protected by internal thermal overload protection.
 5. Low Ambient Kit: Permits operation down to 25 deg F (7 deg C).
 6. Mounting Base: Polyethylene.
 7. Outdoor coil: Coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed. Coils shall be coated for corrosion resistance. Cathodic epoxy type electro-disposition coating formulated for high edge build to plate fin and tube heat exchangers. Coating shall provide excellent resistance and durability to corrosive effects of alkalis, acids, alcohols, petroleum, seawater, salt air and corrosive environments.

2.4 ACCESSORIES

- A. Thermostat: Wired thermostat to control compressor and evaporator fan, with the following features:
 1. Compressor time delay.
 2. 24-hour time control of system stop and start.
 3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
 4. Fan-speed selection including auto setting.
 5. Wireless thermostats are not permitted.
- B. Automatic-reset timer to prevent rapid cycling of compressor.
- C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- D. Drain Hose: For condensate.
- E. Additional Monitoring:
 1. Monitor constant and variable motor loads.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.



- C. Install roof-mounted, compressor-condenser components on equipment supports detailed on the construction plans. Anchor units to supports per plans.
- D. Install seismic restraints.
- E. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch (25 mm). See Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- F. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- G. Provide a secondary drain pan for units located in data rooms, electrical rooms, or similar critical spaces.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26

**SECTION 26 05 13
MEDIUM-VOLTAGE CABLES**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes cables and related cable splices, terminations, and accessories for medium-voltage (2001 to 35,000 V) electrical distribution systems.

1.3 DEFINITIONS

- A. Jacket: A continuous nonmetallic outer covering for conductors or cables.
- B. NETA ATS: InterNational Electrical Testing Association - Acceptance Testing Specification.
- C. Sheath: A continuous metallic covering for conductors or cables.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of cable-include cable manufacturer's complete technical data indicating cable construction, shielding, insulation material, thickness of insulation, jacket, cable stranding, and voltage rating of each type of cable specified, splices and terminations. Indicate place and date of manufacture for each cable, cable accessory, splice and termination.
- B. Samples: 16-inch lengths for each type of cable specified. Submit samples of cable, splice and termination kit for review minimum fourteen (14) days prior to shipment of cable and splice and termination kits to job site.

- C. Shop Drawings: Splice location(s) and detailing for Approval by District. Splicing is not permitted unless specifically approved by District.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, cable splicer and terminator, testing agency. Submit complete documents for each for the approval by the Owner's Representative. Documents shall include the names, qualifications, experience, training certificates of each person intended to perform the splicing, termination and field testing of medium voltage cables approved for installation. Each splicer and terminator shall have minimum ten (10) years' recent experience in installation, splicing and terminating of medium voltage cables similar to those specified on this project. Refer to para 1.6 for additional information.
- B. Material Certificates from the manufacturer: For each type of cable, cable accessory and splicer and termination.
- C. Source quality-control reports. Certified test reports for:
 - 1. Sample test on insulation: Test shall be done at the factory to verify physical properties, heat distortion, and accelerated water absorption in accordance with ICEA S-93-639.
 - 2. Factory Tests: Complete tests shall be done on each length of cable at the cable by the manufacturer's trained testing engineer/technician at the manufacturer's testing facility at the factory in accordance with ICEA S-93-639, and UL-1072. Tests shall include Insulation resistance, power factor, corona level, AC dielectric. Corona test shall be done per AEIC CS8; Section E. Recordings of the tests shall be made on X-Y graph.
 - 3. Furnish six (6) copies of the certified factory test reports to the Owner's Representative complete with X-Y recordings showing the corona test results for review two weeks prior to shipment of cables. Test Report shall include the results of the tests, cable identification, reel number, factory order number, cable length and all cable specifications. Each test report shall be signed by the manufacturer's testing engineer and include the name of the testing engineer/technician, location and date of testing.

4. Submit test reports minimum two (2) weeks prior to shipment of cables to the job site. Cable shall not be installed in any duct or conduit until related all test reports have been reviewed and accepted by the Owner's Representative.
- D. Field quality-control reports. Perform field testing of cables per para 3.2. Submit field test report to owner's representative within two (2) weeks of completion of test.

1.6 QUALITY ASSURANCE

- A. General Requirements: The cable shall be copper, **5KV for 4.16KV system** voltage rating, 133 percent rated, shielded. Aluminum cable will not be accepted.
- B. Materials and installation shall meet or exceed requirements in the following referenced standards.
 1. ICEA S-93-639/ NEMA WC 74.
 2. AEIC CS8.
 3. UL 1072.
 4. IEEE.
 5. ASTM.
 6. NEMA.
- C. The manufacturer shall have a minimum of ten (10) years of experience in manufacturing medium voltage EPR power cables and shall submit a certified copy of its AEIC CS 6 qualification.
- D. Manufacturer shall have ISO 9001 and 9002 Certification. The cable manufacturer shall compound the insulation in its own facility using a closed system to ensure maximum cleanliness. The complete cable shall be manufactured in same manufacturer's manufacturer facility.
- E. American made cable has been acceptable. If non-domestic cabling is submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. All of the testing procedures and results shall be satisfactory to the Owner's representative. The Contractor shall bear all costs for testing and shall be responsible for all costs associated with travel, lodging, etc. for the Owner's Representative to witness the test at the manufacturer's testing facility. The Contractor shall reimburse the Owner at \$1,200 per man day or part thereof for the time required to witness the testing.
- F. Testing: Provide the services of a qualified independent testing laboratory to perform the specified field tests. Notify the Owner's Representative 14 days in advance of performance of Work requiring testing.
- G. Cables, splices and terminations shall be manufactured within twelve (12) months of installation. Each item shall have a permanent marking on the product or the original manufacturers' package indicating the date of manufacture unless otherwise noted. Cables shall have the dates marked on the outer jacket.
- H. Cable, splices and terminations shall be manufactured under a single batch. Furnish a letter from each manufacturer to confirm it.
- I. Cable including insulation, shielding tape shall be clean with smooth surface and does not have any surface abnormalities or ridges.
- J. Installer: Contractor shall engage cable splicers and terminators, trained and certified by splice/termination material manufacturer, to install, splice, and terminate medium-voltage cable of type and rating specified on this project. Training and certification shall be within the last three (3) years from the date of installation.
- K. Testing Agency Qualifications:
 1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of ten (10) years and has permanent in-house testing engineers and technicians involved with testing of medium voltage cables similar to those specified on this project.
 2. Testing company shall be located with 50 miles radius of the project.
 3. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

4. Field Testing technician and supervisor shall have minimum ten (10) years' experience in field testing of medium voltage cables of the type and rating similar to the cables to be tested on this project.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted in writing under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 1. Notify authorized college personnel no fewer than fourteen (14) days in advance of proposed interruption of electric service using "Utility Shut down Request Form" included in division 1.
 2. Do not proceed with interruption of electric service without College's written permission.
 3. Provide temporary standby power through a standby diesel quiet type back-up generator complete with fuel and 7/24 monitoring if the power interruption exceeds 2 hours. Coordinate additional requirements with owner minimum fourteen days in advance.
 4. All utility shutdowns will be done by Owner's authorized personnel unless otherwise noted. Coordinate through Owner's Representative.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers :
 1. Cables:
 - a. Okonite Company (The)
 - b. General Cable Technologies Corporation.
 2. Cable Splicing and Terminating Products and Accessories:
 - a. 3M; Electrical Markets Division.
 - b. G&W Electric Company.
 - c. Thomas & Betts Corporation/Elastimold.
 - d. Tyco Electronics; Raychem Product.
 3. Arc- and Fireproofing Tape:
 - a. Bishop; Model 43A.
 - b. 3M; Model 7700
 4. Voltage Indicators:
 - a. SEL Model **VIN600** or **VIN200**.
 5. Shield Adapter/Grounding Kits:
 - a. Manufacturers: 3M, 8460 series.
- B. Source Limitations: Obtain cables and accessories from a single source from a single manufacturer thru their local authorized distributor.

2.2 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with IEEE C2 and NFPA 70.

2.3 CABLES

- A. Cable Type: Type MV 105.
 1. Suitable for installation in conduit, subject to alternately wet and dry conditions.
 2. To operate satisfactorily, both electrically and mechanically, at conductor temperatures not exceed 105°C continuous for normal loading; 130°C for emergency loading, emergency of 36 hours, 250°C for short circuit loading assuming short circuit duration of two seconds. Emergency overload operation may occur for periods up to 100 hours per year and with as many as five (5) such 100 hour periods within the lifetime of the cable.

- B. Comply with UL 1072, AEIC CS8, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682, and ICEA S-94-649].
- C. Conductor: Soft annealed copper.
- D. Conductor Stranding: Compact round concentric Class B stranded per ASTM B-8 or compact round per ASTM B496.
- E. Strand Shielding: Thermoset EPR based material or a material extruded over the conductors with thermal characteristics equal to or better than those of the insulation; chemically compatible with the conductor and the cable insulation; firmly and continuously bonded to the overlying insulation; easily removable from the conductors; not less than 20 mils (nominal) for compact round and 25 mils (nominal) for compressed conductor, or more than 50 mils thick. Compatibility of material shall be demonstrated by laboratory test results.
- F. Conductor Insulation: Ethylene-propylene rubber (EPR). Insulation: High quality, ethylene-propylene base, thermosetting compound of high dielectric strength with heat, moisture, ozone, and corona resistant properties, homogenous, solid, and applied with good workmanship. Insulation thickness shall be 115 mils minimum average, and 115 mils minimum at any point; meet or exceed the latest editions of Standards ICEA S-93-639, AEIC CS-8 for 133 percent insulation level. EPR insulation compound shall be free from polyethylene.
 - 1. Voltage Rating: 5/8 kV.
 - 2. Insulation Thickness: 133 percent insulation level.
- G. Semi-Conducting Shield: Insulated conductor to have a suitable layer of semi-conducting, extruded, thermosetting, EPR shielding applied directly over the insulation; 32 mils (nominal) thickness; impervious to sunlight, the elements and acid or alkaline soils.
- H. Shielding: Uncoated copper tape, helically applied over insulation .005 inch thick with minimum {25} percent overlap.
- I. Construction: Strand shielding insulation and semi-conducting insulation shield shall be applied in a continuous triple-tandem extrusion process.
- J. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together with ground conductors.
 - 1. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.
- K. Cable Jacket: Sunlight-resistant PVC Jacket shall be 80 mil, minimum average thickness polyvinyl chloride jacket extruded over the shielding tape; smooth, of uniform composition and free of holes, cracks and imperfections; longitudinal shrinkage relative to the insulation less than five percent.
- L. Identification: Provide durable lifetime identification printed, embossed, or engraved on outer surface of the jacket including manufacturer's name, month and year of manufacture, place of manufacture, conductor type and size, insulation thickness in mils, and the rated voltage, all on 3-foot center maximum spacing.
- M. Sealing: Manufacturer shall seal ends of cable with mastic material and tight fitting plastic end cap to prevent entrance of moisture.

2.4 CONNECTORS

- A. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.
- B. Copper-Conductor Connectors: Copper barrel crimped connectors.

2.5 SOLID TERMINATIONS

- A. Multiconductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.
 - 1. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.

2. Heat-shrink sheath seal kit with phase- and ground-conductor re-jacketing tubes, cable-end sealing boot, and sealing plugs for unused ground-wire openings in boot.
- B. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Include shield ground strap for shielded cable terminations. Minimum rating shall be 8KV for cables up to 15KV rated. Basic insulation level (BIL) shall be 110KV minimum.
 1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.
 2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
 3. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
 4. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.
 5. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape; cold-shrink-rubber sleeve; or heat-shrink, plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
 6. Class 3 Terminations: Kit with stress cone and compression-type connector.

2.6 SEPARABLE INSULATED CONNECTORS

- A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals, designed for sealing against moisture. Minimum rating 25KV for 15KV rated cables. Basic insulation level (BIL) shall be 110KV minimum.
- B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables. Suitable for use in underground manholes.
- C. Load-Break Cable Terminators: Elbow-type units with 200-A-load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- D. Dead-Break Cable Terminators: Elbow-type unit with 600A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
 1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
 2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
 3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
 4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.
- F. Provide neon voltage indicator on each splice above grade. The indicator shall provide a flashing signal when the conductor is energized. Indicators shall be replaceable in the field using a high voltage hook stick.
- G. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

- H. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.7 SPLICE KITS

- A. Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.
- B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
 - 1. Combination tape and cold-shrink-rubber sleeve kit with re-jacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
 - 2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
 - 3. Premolded, cold-shrink-rubber, in-line splicing kit.
 - 4. Premolded, EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.
 - 5. Separable multiway splice system with all components for the required splice configuration.
- C. Shield Adapter/Grounding Kits and Jacket Seals:
 - 1. Provide kits consisting of a cold shrink tube, mastic seal strips, constant force spring, preformed ground braid with solder tinned moisture dam and semi-conducting tape. Application and installation shall adhere to manufacturer's instruction information packaged with kit. Alternate materials not provided as part of kit shall not be substituted without written approval from the University Representative. Any other method of building shield grounding and jacket seal (e.g. hand-taped method) shall require written approval including witnessing a sample by the Owner's Representative. See division 1 for more information on substitutions.

2.8 MEDIUM-VOLTAGE TAPES

- A. Ethylene/propylene rubber-based, 30-mil splicing tape, rated for 130 deg C operation. Minimum 3/4 inch wide.
- B. Silicone rubber-based, 12-mil self-fusing tape, rated for 130 deg C operation. Minimum 1-1/2 inches (38 mm) wide.
- C. Insulating-putty, 125-mil elastic filler tape. Minimum 1-1/2 inches wide.

2.9 ARC-PROOFING MATERIALS

- A. Tape for First Course on Metal Objects: 10-mil-thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
- B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, and compatible with cable jacket.
- C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1 inch wide.

2.10 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to [ICEA S-97-682] [ICEA S-94-649] before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cables according to IEEE 576. Cables shall not be installed more than 60 days prior to energization.
- B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.
 - 1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.

2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.
- C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
 2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
 3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
 4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- E. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
- F. Install underground cables according to Section 26 05 33 "Raceways and Boxes for Electrical Systems. Direct-burial installation is not permitted.
- G. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.
- H. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.
- I. Medium voltage splices shall be avoided as far as possible. Splices on existing cable shall be performed after approval from District.
- J. Install cable splices at pull points and elsewhere as indicated; use standard kits. dead-front separable watertight connectors in manholes and other locations subject to water infiltration.
- K. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.
- L. Install separable insulated-connector components as follows:
 1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
 2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
 3. Standoff Insulator: At each terminal junction, with one on each terminal.
- M. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
 1. Clean cable sheath.
 2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
 3. Smooth surface contours with electrical insulation putty.
 4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
 5. Band arc-proofing tape with two layers of 1-inch-wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.
- N. Seal around cables passing through fire-rated elements according to Section 07 84 13 "Penetration Fire stopping."
- O. Install fault indicators on each phase where indicated.
- P. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
- Q. Ground shields of shielded cable at one point only. Maintain shield continuity and connections to metal connection hardware at all connection points.



- R. Identify cables according to Section 26 05 53 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor shall engage an independent qualified testing agency to perform tests and inspections. All costs associated with testing shall be included in the bid. Testing shall be witnessed by College's Authorized representative. Provide minimum fourteen (14) days advance notice.
- B. Perform the following tests and inspections
 1. Perform each visual and mechanical inspection and electrical test stated in latest NETA ATS. Certify compliance with test parameters.
 2. After installing medium-voltage cables and before electrical circuitry has been energized, test each cable with connectors/terminations for compliance with requirements.
 3. Perform direct-current High Potential test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.
 4. Perform Partial Discharge or VLF test of each existing conductor according to NETA ATS, Ch. 7.3.3 and to test equipment per manufacturer's and NETA recommendations.
 5. Perform Dissipation Factor test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
- C. Medium-voltage cables will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.3 PROTECTION

- A. Protect installed cables from entrance of moisture. Provide heat shrink caps per cable manufacturer's written recommendations for cables to be energized later on.

END OF SECTION 26 05 13

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
- B. Related Requirements:
 - 1. Section 26 05 13 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.
 - 2. Section 26 05 23 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2 and 3 control cables.
 - 3. Section 26 05 33 "Raceways and Boxes for Electrical Systems"
 - 4. Section 26 05 53 "Identification for Electrical Systems."

1.3 DEFINITIONS

- A. ASTM: American Society of Testing Materials.
- B. ICEA: Insulated Cable Engineers Association.
- C. IEEE: Institute of Electrical & Electronics Engineers.
- D. NEMA: National Electrical Manufacturers Association.
- E. NETA ATS: InterNational Electrical Testing Association - Acceptance Testing Specification.
- F. VFC: Variable frequency controller.

1.4 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical data for each type of product, indicating conductor/cable construction, insulation material, thickness of insulation, jacket, cable stranding, and voltage rating of each type of conductor/cable specified, splices and terminations. Indicate date and place of manufacture for each conductor/cable, cable, splice and termination.
- B. Manufacturer's ISO certification.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Independent Testing Agency.
- B. Field quality-control reports. Perform field testing of cables per para 3.8. Submit six (6) copies of field test reports to owner's representative within two (2) weeks of completion of test.

1.6 QUALITY ASSURANCE

- A. General Requirements: The low voltage power conductors and cable shall be copper, minimum 600V rated unless otherwise indicated. Aluminum conductors and cables shall not be accepted unless otherwise indicated.
- B. Materials and installation shall meet or exceed requirements in the following referenced standards and shall be listed and labelled by UL.
 - 1. ICEA S-93-639/ NEMA WC 74.
 - 2. AEIC CS8.
 - 3. UL 1072.
 - 4. IEEE.

5. ASTM.
6. NEMA.
- C. Conductors and cables shall be of the same manufacturer, and shipped to the job site in original unbroken reels.
- D. Conductors and cables shall be manufactured within twelve (12) months of installation. Date of manufacture shall be clearly marked on conductors or conductor reels.
- E. Manufacturer shall have minimum ten (10) years experience in the manufacture of conductors and cables similar to those specified on this project.
- F. Manufacturer shall have ISO 9001 and ISO 9002 certification.
- G. All conductors and cables shall be new and supplied by a local distributor.
- H. American made conductors and cables have been acceptable. If non-domestic product is submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. All of the testing procedures and results shall be satisfactory to the Owner's representative. The Contractor shall bear all costs for testing and shall be responsible for all costs associated with travel, lodging, etc. for the Owner's Representative to witness the test at the manufacturer's testing facility. The Contractor shall reimburse the Owner at \$1,200 per man day or part thereof for the time required to witness the testing.
- I. Testing: Provide the services of an independent qualified testing laboratory to perform the specified field tests. Notify the College Representatives fourteen (14) days in advance of performance of work requiring testing.
- J. Conductors, cables, splices and terminations shall be manufactured within twelve (12) months of installation. Each item shall have a permanent marking on the product or the original manufacturers' package indicating the date of manufacture unless otherwise noted.
- K. Testing Agency Qualifications:
 1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of last ten (10) years and has permanent in-house testing engineers and technicians involved with testing of low voltage electrical power conductors and cables similar to those specified on this project.
 2. Testing company shall be located within 50 miles radius of the project.
 3. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
 4. Field Testing technician and supervisor shall have minimum ten (10) years' experience in field testing of low voltage power conductors and cables of the type and rating similar to the conductors and cables to be tested on this project.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 1. General Cable Technologies Corporation.
 2. Southwire Incorporated
 3. Alpha Wire.
 4. Belden Inc.
 5. Encore Wire Corporation..
- B. Conductor Material: Electrical grade, soft drawn annealed copper, 98 percent conductivity, and fabricated in accordance with ASTM and IPCEA standards. Minimum size is number 12 for branch circuits, number 14 stranded for control wiring. Aluminum conductors are not permitted. MC- Cables are not permitted.
- C. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

- D. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for [Type THHN-2-THWN-2] [Type XHHW-2].
- E. VFC Cable:
 - 1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
 - 2. Type TC-ER with oversized crosslinked polyethylene insulation, [spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire], and sunlight- and oil-resistant outer PVC jacket.
 - 3. Comply with UL requirements for cables in direct burial applications.
- F. Provide separate neutral with each branch circuit serving outlets. When dedicated neutrals are provided, use color spiral to match associated phase.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Spears-DS400 Dri Splice Pre-filled
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- C. Copper conductors shall be terminated in copper or bronze mechanical connectors or lugs or tool applied compression connections made of copper for all connections except those on wiring devices.
- D. Splices in wires No. 10 and smaller shall be made with twist-on splicing connector in accordance with UL486-C. Connections in wires No. 8 and larger shall be made with compression type connectors in accordance with UL486-A and wrapped with insulated tape in accordance with UL501. Insulating tape shall be applied in a minimum of two layers of half wrap or built to match the overall insulation of the wire.
- E. Splices in underground pull boxes shall be made submersible type and made using “3M” Scotch-cast epoxy kits.
- F. Pressure type connectors are not permitted.

2.3 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: [Type THHN-2-THWN-2, single conductors in raceway] [Type XHHW-2, single conductors in raceway]
- B. Exposed Feeders: [Type XHHW-2, single conductors in raceway]
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: [Type THHN-2-THWN-2, single conductors in raceway].
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: [Type THHN-2-THWN-2, single conductors in raceway] [Type XHHW-2, single conductors in raceway]
- E. Feeders Installed below Raised Flooring: [Type THHN-2-THWN-2, single conductors in raceway]

- F. Feeders in Cable Tray: **[Type THHN-2-THWN-2, single conductors in raceway] [Type XHHW-2, single conductors larger than No. 1/0 AWG].**
- G. Exposed Branch Circuits, Including in Crawlspace: **[Type THHN-2-THWN-2, single conductors in raceway].**
- H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: **[Type THHN-2-THWN-2, single conductors in raceway].**
- I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: **[Type THHN-2-THWN-2, single conductors in raceway] [Type XHHW-2, single conductors in raceway]**
- J. Branch Circuits Installed below Raised Flooring: **[Type THHN-2-THWN-2, single conductors in raceway] [Armored cable, Type AC].**
- K. Branch Circuits in Cable Tray: **[Type THHN-2-THWN-2, single conductors in raceway] [Type XHHW-2, single conductors larger than No. 1/0 AWG] .**
- L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- M. VFC Output Circuits: **[Type XHHW-2 in metal conduit] [Type TC-ER cable][with braided shield][with dual tape shield].**

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. All conductors and cables shall be installed in a raceway.
- B. Before installing conductors and cables in existing conduits, verify the continuity of each conduit; each surface conduit is properly supported per code and clear of any debris.
- C. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- D. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- G. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
- H. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors].
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.5 IDENTIFICATION

- A. Each conductor shall be factory color coded by conductor manufacturer. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.



3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage an independent qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance conductors, feeder conductors and the conductors feeding the following critical equipment and services] for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical tests stated in latest NETA Acceptance Testing Specification section 7.3.2 (Inspection and Test Procedures-Cables, Low Voltage-600V Maximum). Certify compliance with test parameters per NETA tables.
 - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- D. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements. Include color scan images.
 - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- E. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 26 05 19

SECTION 26 05 23
CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Backboards
 - 2. Singlemode optical-fiber cabling.
 - 3. UTP cabling.
 - 4. Identification products.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
- D. RCDD: Registered Communications Distribution Designer.
- E. UTP: Unshielded twisted pair.
- F. OSP: Outside Plant

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Manufacturers catalog cut sheets and product data sheets for each item listed in PART 2 – PRODUCTS indicating the part number.
 - 2. Data sheets for the fiber cables which include cable breakout information.
 - 3. A copy of the level 6 cable termination practices to which you will adhere.
- B. Record Drawings: Submit to College Representative, as specified in Part 3.
- C. A list of subcontractors, including a description of the work they will be carrying out. Describe the proportion of the total telecommunications work that will be performed by each subcontracting company.
- D. Certificates: Hard copies for each type of cable, connector, and terminal device.
- E. Qualification Data: For Installer. Submit at least three references for telecommunications cabling jobs already completed, involving both fiber optics and twisted pair cabling, similar in scope to the project described herein. Include, for each customer reference, the following information: Company name, address, phone number, name and email address of contact and type of job completed.
- F. Test Reports: Field quality-control test reports as specified in Part 3.

1.5 QUALITY ASSURANCE

- A. Comply with the following codes and standards as a minimum requirement:
 - 1. Telecommunication Drawings (TE Series) as provided by College.
 - 2. Underwriters Laboratories Specifications, UL13, UL444 and UL969.
 - 3. NFPA 70, National Electrical Code (NEC) Chapter 8 – Communications Systems.
 - 4. NFPA 75, Standard for the Protection of Electronic Computer/Data Processing Equipment.

5. NFPA 76, Recommended Practice for the Fire Protection of Telecommunications Facilities.
 6. NFPA 101, Life Safety Code.
 7. California Electric Code (CEC).
 8. ANSI/TIA/EIA-568-B, Commercial Building Telecommunications Cabling Standard.
 9. ANSI/TIA/EIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces.
 10. ANSI/TIA/EIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Building.
 11. TIA-607-B Commercial Building Grounding and Bonding Requirements for Telecommunications.
 12. ANSI/TIA/EIA-455 Fiber Optic Test Standards.
 13. ANSI/TIA/EIA-526 Optical Fiber System Test Procedures.
 14. Telecommunications Distribution Methods Manual (TDMM) 10th Edition Vol.1 & Vol. 2. by Building Industry Consulting Service International (BICSI).
 15. Customer-Owned Outside Plant (CO-OSP) design Manual (BICSI).
 16. ANSI/TIA/EIA-758-1 Customer Owned Outside Plant Standard Addendum 1 – OSP Optical Fiber Cabling Practices.
 17. IEEE802.3ab Institute of Electrical and Electronics Engineers Standards for Gigabit Ethernet
 18. Rural Utilities Services (formerly REA) Specifications.
- B. Manufacturers' Qualifications: Firms regularly engaged in the manufacture of telephone and data communications system cables and components, whose products have been in satisfactory use in similar service for not less than five years.
- C. Contractors' Qualifications:
1. Contractor shall have on staff a Registered Communication Distribution Designer (RCDD) as certified by BICSI.
 2. Contractor and their personnel regularly engaged in the installation of telephone, video and data communications systems of a similar type, scope, size and complexity.
 3. Contractor shall have a minimum of five years' experience in projects of similar size and scope. Firms shall list a minimum of five projects of similar size and scope within the last five years.
 4. Contractor must have a service facility within a 50-mile radius of the location of the project. The installer must be able to respond to call outs in four hours or less.

1.6 COORDINATION

- A. Firm shall meet with the College's Telecommunications personnel a minimum of four weeks prior to start of installation. Provide two weeks prior notice of the meeting to the College's Telecommunication Representative.
- B. The College's Telecommunication Representative shall witness all cable testing. Provide two weeks advance notice of testing dates.
- C. All cables and innerducts are to be placed according to this document and the telecommunications cabling drawings. Coordinate and verify in field, splice points and terminations (patch panels, punch down blocks, connectors, backboards, etc.), with the College's Telecommunication Representative prior to start of work.
- D. Coordinate closely with the College's Telecommunication Representative as to the location(s) of terminal boards. College's Telecommunication Representative shall provide drawings indicating backboard layouts.
- E. The contractor shall observe the following procedure in order to work in College's existing telecommunications rooms:
 1. Give one-week advance notice to the College's Telecommunication Representative prior to start of work in those rooms.
 2. Contractor shall be responsible to keep these rooms secured at all times and locked at the end of each working day.

- F. The contractor is responsible for identifying any problems or discrepancies in the specifications or drawings in advance and for bringing them to the attention of the College's Telecommunication Representative.
- G. Record agreements reached in meetings or in the field and distribute to all participants.

1.7 WARRANTY

- A. Provide a minimum one-year warranty on all labor and materials. The installer must be able to respond to call outs in four hours or less.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PERFORMANCE REQUIREMENTS

- A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - 1. Flame Travel Distance: 60 inches (1520 mm) or less.
 - 2. Peak Optical Smoke Density: 0.5 or less.
 - 3. Average Optical Smoke Density: 0.15 or less.
- B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.3 BACKBOARDS

- A. Description: Plywood, fire-retardant factory treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels in Section 06 10 00 "Rough Carpentry."
- B. Painting: Paint plywood on all sides and edges with fire retardant paint as indicated on drawings. Color shall be selected by College Representative. Comply with requirements in Section 09 91 23 "Interior Painting."

2.4 OPTICAL-FIBER CABLE AND TERMINATION HARDWARE

- A. Manufacturer:
 - 1. Sumotomo Air Blown Fiber
- B. Cables: Sumotomo Air Blown Fiber complying with UL and CEC requirements.
- C. Dual-Window Fiber Optic Cables:
 - 1. Single Mode Fiber:
 - a. All-glass, graded index fiber.
 - b. Core/cladding: 8.3/125 μ m
 - 2. Maximum Attenuation:
 - a. Outside Cable:
 - 1) 0.4 dB/km at 1310 nm.
 - 2) 0.3 dB/km and 1550 nm.
 - b. Inside Cable: 1.0 dB/km at 1310nm and 1550 nm.
- D. Fiber Entrance Cable: Comprised of 12 strands of singlemode fiber as noted on drawings. The cables shall be of loosely buffered, gel filled construction.
- E. Fiber Patch Panels: it is required to match existing Campus standards, and no other product shall be furnished.

1. Wall-Mounted:
 - a. 24-port patch panel.
2. Adapter Plates:
 - a. Single mode 12 port, LC-style, snap-in.
- F. Fiber Optic Connectors: FuseLite Splice-On connectors.
 1. Single Mode - LC Couplers and Connectors:
 2. Insertion loss for a mated pair of connectors shall not be more than 0.75 dB.
- G. Innerducts: 1in., corrugated and pre-lubricated.
 1. Color: Orange.
- H. Warning Tags: it is required to match existing Campus standards, and no other product shall be furnished.

2.5 UTP CABLE

- A. Cables: Comply with ANSI EIA/TIA-568-B standard, ICEA specifications, UL and CEC requirements.
- B. Twisted Pair Horizontal Cables:
 1. 4 pair, UTP, UL Level 6, type CMR or CMP, depending upon the environment in which the cables are placed, with performance characteristics that meet or exceed TIA/EIA-568-B.2-1 Category 6 requirements.
 2. 4 pair, UTP, UL Level 6, type OSP, for installation in outside environment, with performance characteristics that meet or exceed TIA/EIA-568-C.2 Category 6 requirements.
 3. The cables shall be manufactured by one of the following companies: General Cable, Mohawk, AMP, NORDX, Avaya, Superior Essex, Belden or Berk-Tek.
- C. Faceplate/Jacks: Coordinate color of faceplates and outlets with Division 26 Electrical Sections and with existing outlets.
 1. Manufacturer: it is required to match existing Campus standards, and no other product shall be furnished.
 - a. Outlets: Subject to compliance with requirements, provide the following:
 - 1) Single gang, 2-port faceplate.
 - 2) Single gang, 4-port face plate.
 - 3) Single gang, 6-port face plate.
 - 4) Four-port, four-duplex mounting strap.
 - 5) Category 6 RJ45 Module.
 - 6) Strain Relief (Cat 6).
 - b. Patch Panels: Subject to compliance with requirements, provide the following:
 - 1) Rack Mount 24 port Patch Panel Cat6.
 - 2) Cable support bars, 5-in. deep.
 - c. Wall mount adaptors for twisted pair patch panels:
- D. "D" Rings: Subject to compliance with requirements, provide the following, or equal:
 1. Graybar Metal; no. GB13C.
- E. Conduit Sealant: Subject to compliance with requirements, provide one of the following, or equal:
 1. SEMCO; no. PR821.
 2. SEMCO; no. PR855.

2.6 INTERBUILDING COPPER CABLE (GEL-FILLED)

- A. Material
 1. Application: Use for outside conduit and direct buried applications.
 2. Compliance: RUS Specification PE-89.
 3. Core Construction
 4. Conductors: Solid, annealed copper, 24 AWG unless noted on design documents.

5. Insulation: Solid, high density polyethylene, color coded in accordance with telephone industry standards.
6. Twisted Pairs: Insulated conductors twisted into pairs with varying lay lengths to minimize crosstalk. Standard capacitance shall be 83 to 87 nanofarads per mile and a staggered twist design.
7. Core Assembly: Cables of 25 pairs and less formed by assembling pairs together in a single group. Cables of more than 25 pairs formed by twisted pairs arranged in groups with each group having a color coded unit binder.
8. Filling Compound: Core assembly completely filled with Foam skin insulation at conductors
9. Core Wrap: Non-hygroscopic dielectric tape applied longitudinally with an overlap.
10. Qualpeth Sheath
11. Aluminum Shield: Corrugated, copolymer coated, .008" aluminum tape applied longitudinally with an overlap. The sheath interfaces are flooded with an adhesive water blocking compound.
12. Jacket: Black, linear low density polyethylene.
13. Cable sizes defined in design documents.

B. Manufacturer: Mohawk, General Cable or equal.

2.7 UTP CABLE HARDWARE

- A. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
- B. Jacks and Jack Assemblies: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA-568-C.1.
- C. Patch Cords: Factory-made, four-pair cables in 36-inch (900-mm) lengths; terminated with eight-position modular plug at each end.
 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
 2. Patch cords shall have color-coded boots for circuit identification.

2.8 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test UTP cables according to TIA-568-C.2.
- C. Factory test optical-fiber cables according to TIA-568-C.3.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Cables shall be manufactured within 12 months of installation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Field verify the actual cable lengths required prior to bidding.
- C. Verify the actual lengths using true-tape prior to placing an order for the cables.
- D. Provide a complete cabling system.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install cables using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.
- B. Install cables without damaging conductors, shield, or jacket.

- C. Do not bend cables, in handling or in installing, to smaller radii than minimum recommended by manufacturer.
- D. Cables shall not be installed until raceway system is complete and install cables within 30 days of use.
- E. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
 - 1. Pull cables simultaneously if more than one is being installed in same raceway.
 - 2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 - 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.
- F. Separation of Wires: Comply with ANSI/TIA/EIA-569-B rules for separating unshielded telecommunication cabling from potential EMI sources, including electrical power lines and equipment.
- G. Provide plenum rated cables (including: station, coaxial, risers, fiber and inner duct) in plenum rated areas indicated on the drawings in compliance with CEC. Field verify actual locations with the Division 15 contractor prior to start of installation.
- H. Provide firestopping for penetrations through fire-rated elements in accordance with CEC and NFPA-101. Use firestop materials and systems approved by the College Fire Marshal.
 - 1. Coordinate requirements with the College Fire Marshal.
- I. Terminate horizontal cabling on same floor upon which it originates. If there are floor monuments, or outlets installed in ceiling area of a floor, they will terminate cabling in Telecommunications Equipment Room (TER) or Telecommunication Room (TR) located on the same floor.
- J. Provide a 3/8 in. pull rope in each conduit that is used for placing entrance/riser cables or inner duct. The rope is intended to be used by the College for future cable pulls, and thus shall not be twisted around cables as it is pulled in. The rope must have a minimum of 200 lbs tensile pull strength.
- K. Place a pull string (jet line or equivalent) along with the station cabling when placed in conduits, power poles or raceways. Secure the pull line at each end of the conduits or raceways leaving adequate slack for future use.
- L. Cables shall be racked securely and neatly.
- M. Where power receptacles are indicated to require weatherproof outlet boxes or stainless steel faceplates, the telecommunications outlets in that area shall require the same type of box or faceplate. In the weatherproof outlets, the RJ-45 inserts shall be mounted in a four port duplex mounting strap (AMP part # 1339120-X).
- N. Work shall be performed in a safe and orderly manner. Debris, trash, leftover materials, and similar matter shall be removed from terminal rooms and the general work areas and disposed of before leaving the job site each day.
- O. Damage by the contractor to existing telecommunications facilities and equipment, cables, inner ducts and to other existing building structures including walls, ceiling tiles, water pipes etc., shall be repaired by the contractor at no additional cost to the College. Notify the College's Telecommunication Representative immediately in case of such an event. Problems affecting normal operation that occur in the new cables shall be corrected by the contractor, at no cost to the College, prior to final acceptance by the College.
- P. Outlet boxes and faceplates shall be installed vertically with the individual jacks at the bottom unless noted otherwise.
- Q. Use appropriate Velcro tywraps to bundle station cables together. Use of plastic tywraps is not permitted.
- R. Conduit space is at a premium, and is to be conserved to the maximum extent possible. Vacant conduits are to be used only when others are full.
- S. Terminate all cables at both ends with the designated connections.

- T. Remove all abandoned cables per CEC requirements.
- U. UTP Cable Installation:
 - 1. Comply with TIA-568-C.2.
 - 2. Install termination hardware as specified in Section 27 15 00 "Communications Horizontal Cabling" unless otherwise indicated.
 - 3. Do not untwist UTP cables more than 1/2 inch (12 mm) at the point of termination to maintain cable geometry.
- V. Optical-Fiber Cable Installation:
 - 1. Comply with TIA-568-C.3.
 - 2. Terminate cable on connecting hardware that is rack or cabinet mounted.
- W. Separation from EMI Sources:
 - 1. Comply with BICSI TDMM and TIA-569-C recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
 - 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches (305 mm).
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
 - 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches (305 mm).
 - 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
 - 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches (1200 mm).
 - 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.3 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.4 FIRESTOPPING

- A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."
- B. Comply with TIA-569-C, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.5 GROUNDING

- A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage control wiring and cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.6 IDENTIFICATION

- A. System Numbering Scheme: ([FLOOR #].[TERMINAL #]).[JACK #].
 - 1. ([FLOOR #], [TERMINAL #]) identifies the terminal to which the jack is wired and assigned by the College's Telecommunication Representative.
 - 2. [JACK #] is unique to each terminal and sequential, starting with 1, given to each individual faceplate. Thus, the 16th jack wired to the 2nd terminal on the 3rd floor would be labeled "3.2.16". Each faceplate shall be assigned a single jack number.
- B. Workstation: Label cables within outlet boxes.
- C. Cables, General: Label each cable within four inches of each termination, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
- D. Mark topside faceplates neatly and legibly with its jack number. Label each module as "A", "B", "C" or "D", starting at the top left, going top to bottom.
- E. Cable Schedule: Post in a prominent location in the each new TER, TE, or Terminal. Indicate TR or Terminal name with incoming and outgoing cables (with their origination, destination and cable counts). The schedule shall be laminated for protection.
- F. Utilize a label maker for labeling. Use an appropriate label maker such as P-touch model PT-110 or equal (no known equal). Handwritten labels are not acceptable except on punch blocks.
- G. Label fiber patch panels with cable name and destination.

3.7 TESTING

- A. Submit one electronic copy for each of the following; fiber optic test report (attachment "A") showing the decibel loss for both the OTDR and power meter, individual fiber OTDR tests, fiber power meter tests, and Category 6 cable tests on disk.
- B. Submit one hard copy (printout) of the fiber optic test report (attachment "A") showing the decibel loss for both the OTDR and power meter, individual fiber OTDR traces, twisted pair entrance and riser cables, and coaxial horizontal cable tests in a binder format.
- C. Submit test materials to the College's Telecommunication Representative within five working days of completion of tests.
- D. Remove malfunctioning units, replace with new units, and retest as specified. Repair any other defects.
- E. Fiber Optic Entrance, Backbone and Horizontal cables:
 - 1. Test "dual-window" fiber cables at both "windows". The wavelengths are 1310 and 1550 nm for single mode cables.
 - 2. Terminated fibers: OTDR test in one direction and power meter test in the opposite direction.
 - 3. Un-terminated fibers: OTDR test in both directions.
 - 4. Test through all installed components, including splices, jumpers, connectors and bulkhead couplers, where supplied.
- F. Twisted Pair Entrance and Backbone Cables:
 - 1. Test the finished product for opens, shorts, grounds, reversals and transpositions. Provide written test results. Repair defects.
 - 2. The entrance cables shall be tested from their origination points in the Node rooms or other locations through stub cables, splices and protectors to the punch blocks in the Entrance Facility (EF), TER, or TR.
 - 3. The backbone cables shall be tested from the punch blocks in the Equipment Room to the punch blocks in the ER, TR, or TE. If the cable is continued to patch panels, they shall be included in the test procedures.
- G. Twisted Pair Horizontal Cables:
 - 1. Test cable pairs for opens, shorts, grounds and transpositions. Repair defects.

2. Perform Category 6 Permanent Link Performance/Certification Test on installed cable links (station jack to patch panel), for conformance with ANSI/TIA/EIA-568-B Telecommunications Wiring Standards and 1000Base-T (IEEE802.3ab) Gigabit Ethernet standard. Use test instruments capable of performing Category 6 testing.
3. Two weeks prior to testing, provide the make and model of the test equipment.
4. Submit test reports and include, as a minimum, the following information:
 - a. Make and model of the test equipment.
 - b. Test date.
 - c. Test configuration and test name.
 - d. Jack number.
 - e. Certification (pass/fail) that link complies with ANSI/TIA/EIA-568-B.

3.8 RECORD DRAWINGS

- A. Submit one complete set of as-built drawings to College Telecommunications representative 4 weeks before building occupancy. Drawings shall be rendered in a neat and legible manner by a competent draftsman, and shall include:
 1. Building floor plans showing telecommunication outlets (with identification) and cable pathways for installed cabling. Show labels for telecommunication closets.
 2. Manhole/handhole foldout drawings for each manhole/handhole showing duct usage and installed cables, including previously installed cables.
- B. An additional copy of the as-built floor plans shall be posted in a prominent location in each TER or TR.
- C. Record documents shall indicate actual conditions for the complete telecommunications cabling system after placement, termination and testing, and shall include:
 1. Beginning and ending footage markers from each fiber, coax and twisted pair entrance cable.
- D. Submit Drawings in AutoCAD file format on electronic media disc.

END OF SECTION 26 05 23

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Grounding systems and equipment.
- B. Section includes grounding systems and equipment, plus the following special applications:
 - 1. Overhead-line grounding.
 - 2. Underground distribution grounding.
 - 3. Ground bonding common with lightning protection system.

1.3 DEFINITIONS:

- A. NETA ATS: InterNational Electrical Testing Association - Acceptance Testing Specification.
- B. NETA MTS: InterNational Electrical Testing Association - Maintenance Testing Specification.
- C. NFPA : National Fire Protection Association.

1.4 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical catalog cuts for each type of product indicated.
- B. Shop Drawings: Site drawings to scale including details showing location and size of each field connection of grounding system.
 - 1. Wiring Diagrams: Differentiate between manufacturer installed and field installed wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Informational Submittals: Plans drawn to scale (1/4"=1'-0") showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Ground rings.
 - 4. Grounding conductors, connectors.
 - 5. Grounding arrangements and connections for separately derived systems.
 - 6. Grounding for sensitive electronic equipment.
- B. Qualification Data: For qualified independent testing agency and testing agency's field supervisor.
- C. Field quality-control reports. Submit written test reports including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals, include the following:
 - 1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, grounding connections for separately derived systems based on NETA MTS and NFPA 70B.
 - a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - b. Include recommended testing intervals.



1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications:
 - 1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of last ten (10) years and has permanent in-house testing engineers and technicians involved with testing of grounding systems similar to those specified on this project.
 - 2. Testing company shall be located with 50 miles radius of the project.
 - 3. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
 - 4. Field Testing technician and supervisor shall have minimum ten (10) years' experience in field testing of rounding systems of the type and rating similar to the systems to be tested on this project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 GROUNDING ELECTRODES, CONDUCTORS, CONNECTOR, BUS:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal:
 - 1. Grounding Connectors, Bars and Rods:
 - a. Erico Inc.; Electrical Product Group
 - b. Framatome Connectors/Burndy Electrical.
 - c. Ideal Industries, Inc.
 - d. O-Z/Gedney Co.; a business of the EGS Electrical Group.
 - e. Thomas & Betts, Electrical.
 - 2. Grounding Conductors and cables:
 - a. Southwire
 - b. American Insulated Wire
 - c. Okonite

2.2 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
 - 1. No. 4 AWG minimum, soft-drawn copper.
 - 2. Conductor Protector: Half-round PVC or wood molding; if wood, use pressure-treated fir, cypress, or cedar.
- D. Grounding Bus: Predrilled rectangular bars of annealed copper, [1/4 by 4 inches (6.3 by 100 mm)] in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.



2.3 CONNECTORS

- A. Listed and labeled by UL for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad 3/4 inch by 10 feet (19 mm by 3 m) in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. [8] AWG and smaller, and stranded conductors for No. [6] AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches (600 mm) below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING OVERHEAD LINES

- A. Comply with IEEE C2 grounding requirements.
- B. Install two parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 ohms.
- C. Drive ground rods until tops are 12 inches (300 mm) below finished grade in undisturbed earth.
- D. Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.
- E. Lightning Arrester Grounding Conductors: Separate from other grounding conductors.
- F. Secondary Neutral and Transformer Enclosure: Interconnect and connect to grounding conductor.
- G. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communication service and transformer spaces.

3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Install #4/0 bare copper ground wire loop around the outside perimeter of the manhole, in soil, 12" above bottom of manhole. Cadweld ground wire loop to #4/0 bare copper ground wire connecting all exposed metal parts inside the manhole through a 1" opening at the top of manhole wall. Seal and waterproof opening after wire installation.
- D. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- E. Pad-Mounted Transformers and Medium Voltage Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.4 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits in the same conduit containing phase and neutral conductors. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
 - 10. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment. Verify requirements with X-ray equipment supplier prior to rough-ins.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each air unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.



- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- G. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
 - 1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch (6.3-by-100-by-300-mm) grounding bus.
 - 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
 - 4. All metallic conduits and cable tray shall be continuously bonded to maintain low resistance ground path and bonded back to the central equipment by the use of bonding jumpers where needed.
- H. [Metal] [and] [Wood] Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode next to the pole and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors. Provide a handhole for the grounding electrode at each pole.

3.5 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade using exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. For grounding electrode system, install ground rods at least three rods (unless otherwise indicated on the drawings), spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.
 - 1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
 - 2. Test Wells near light poles: Coordinate location with landscape drawings and install one at each pole. Test well shall be open bottom and installed on a 12"H bed of gravel or crushed stone (1" size).



- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Separately Derived System (SDS): All multiple branch metal water piping laterals originating from outside the area being served by the SDS and which serve the same area being served by the SDS shall be bonded to the common grounding electrode (GE) or the common grounding electrode conductor (GEC). The bonding connection shall be made at each level that the metal water piping serves. When multiple SDS's are installed or a SDS serves multiple levels of a structure, a copper common GEC shall be installed for the SDS as permitted in NFPA 70 article 250.30 (D)3 and sized per article 250.30 (A) and (B).
 - 3. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 4. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
- I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
 - 1. Install tinned-copper conductor not less than No. [4/0] AWG for ground ring and for taps to building steel.
 - 2. Bury ground ring not less than 24 inches (600 mm) from building's foundation.
- J. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. [4]AWG.
 - 1. If concrete foundation is less than [20 feet (6 m) long, coil excess conductor within base of foundation.
 - 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.6 LABELING

- A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
 - 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."



3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage an independent qualified testing agency to perform tests and inspections. Refer to section
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal[, at ground test wells] [, and at individual ground rods]. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 - 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- E. Grounding system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: [5] ohms.
 - 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: [5] ohms.
 - 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: [3] ohms.
 - 4. Power Distribution Units or Panelboards Serving Electronic Equipment: [1] ohm(s).
 - 5. Substations and Pad-Mounted Equipment: [5] ohms.
 - 6. Manhole Grounds: [10] ohms.
- H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
 - 1. Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of [five] <Insert number> times the applied force.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Nonmetallic slotted channel systems. Include Product Data for components.
 - 4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.



1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 07 72 00 "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 6. Channel Dimensions: Selected for applicable load criteria.
 - a. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
 - 7. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 8. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 - 9. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 - 10. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 - 11. Rated Strength: Selected to suit applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.



- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 05 50 00 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as **[required by] [scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in] NFPA 70**. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.

- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, [EMT] [IMC] [RMC] [EMT, IMC, and RMC] may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 6. To Steel: [Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts] and [Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69].
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use [3000-psi (20.7-MPa)], 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in [Section 03 30 00 "Cast-in-Place Concrete."] [Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."]
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.



3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Comply with requirements in **[Section 09 91 13 "Exterior Painting"] [Section 09 91 23 "Interior Painting"] [and] [Section 099600 "High Performance Coatings"] <Insert other painting Sections>** for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

**SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Nonmetal conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Nonmetal wireways and auxiliary gutters.
 - 5. Surface raceways.
 - 6. Boxes, enclosures, and cabinets.
 - 7. Handholes and boxes for exterior underground cabling.
- B. Related Requirements:
 - 1. Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. EMT: Electrical metal tubing
- C. ENT: Electrical non-metallic tubing
- D. GRC: Galvanized rigid steel conduit.
- E. HDPE: High density polyethylene pipe
- F. IMC: Intermediate metal conduit.
- G. LFMC: Liquidtite flexible metal conduit
- H. LFNC: Liquidtite flexible non-metallic conduit.
- I. RNC: Rigid non-metallic conduit
- J. RTRC: Reinforced thermosetting resin conduit

1.4 QUALITY ASSURANCE:

- A. Each conduit shall bear manufacturer's trademark and UL label.
- B. Each type of conduit and fittings shall be of a single manufacturer. Multiple manufacturer's of the same material are not acceptable.
- C. Comply with California Electric Code (CEC)

1.5 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
 - 2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the



California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

- C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.
- D. Samples: For **[wireways]** **[nonmetallic wireways]** **[and]** **[surface raceways]** and for each color and texture specified, [12 inches (300 mm) long.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of conduit groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - 4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
- D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements provide products by one of the following
 - 1. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 2. Electri-Flex Company.
 - 3. O-Z/Gedney; a brand of EGS Electrical Group.
 - 4. Republic Conduit.
 - 5. Robroy Industries.
 - 6. Thomas & Betts Corporation.
 - 7. Western Tube and Conduit Corporation.
 - 8. Wheatland Tube Company; a division of John Maneely Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be UL listed and labeled as defined in NFPA 70, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. ARC: Comply with ANSI C80.5 and UL 6A.
- E. IMC: Comply with ANSI C80.6 and UL 1242.
- F. PVC-Coated Steel Conduit: PVC-coated [rigid steel conduit].
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- G. EMT: Comply with ANSI C80.3 and UL 797.
- H. FMC: Comply with UL 1; zinc-coated steel.

- I. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- J. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel
 - b. Type: compression.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 - 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- K. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements provide products by one of the following.
 - 1. CANTEX Inc.
 - 2. Condux International, Inc.
 - 3. Electri-Flex Company.
 - 4. Lamson & Sessions; Carlon Electrical Products.
 - 5. RACO; a Hubbell company.
 - 6. Thomas & Betts Corporation.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. ENT: Comply with NEMA TC 13 and UL 1653.
- D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. LFNC: Comply with UL 1660.
- F. Rigid HDPE: Comply with UL 651A.
- G. Continuous HDPE: Comply with UL 651B.
- H. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
- I. RTRC: Comply with UL 1684A and NEMA TC 14.
- J. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- K. Fittings for LFNC: Comply with UL 514B.
- L. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- M. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman; a Pentair company.
 - 3. Mono-Systems, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 3R unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: [**Hinged type**] [**Screw-cover type**] unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements provide products by one of the following.
 1. Allied Moulded Products, Inc.
 2. Hoffman; a Pentair company.
 3. Lamson & Sessions; Carlon Electrical Products.
- B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- F. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- G. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be UL listed and labeled as defined in NFPA 70, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color.
 1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following
 - a. Hubbell Wiring Systems
 - b. Wiremold / Legrand.
 - c. Mono-Systems, Inc.
 - d. Panduit Corp.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. Hubbell Incorporated; Wiring Device-Kellems Division.
 - b. Wiremold / Legrand.
 - c. Mono-Systems, Inc.
 - d. Panduit Corp.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following
1. Cooper Technologies Company; Cooper Crouse-Hinds.
 2. EGS/Appleton Electric.
 3. Hoffman; a Pentair company.
 4. Hubbell Incorporated; Killark Division.
 5. O-Z/Gedney; a brand of EGS Electrical Group.
 6. RACO; a Hubbell Company.
 7. Robroy Industries.
 8. Thomas & Betts Corporation.
 9. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Metal Floor Boxes:
1. Material: **[Cast metal]** [or] **[sheet metal]**.
 2. Type: **[Fully adjustable]** **[Semi-adjustable]**.
 3. Shape: Rectangular.
 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 5. Manufacturer: ["Legrand" Wiremold Resource RFB Series](#).
 - a. "Legrand" is a Board of Trustees Approved Sole Source Item. No substitutions will be accepted.
- G. Nonmetallic Floor Boxes: Nonadjustable, **[round]** **[rectangular]**.
1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.
- I. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).
1. Listing and Labeling: Paddle fan outlet boxes shall be UL listed and labeled as defined in NFPA 70, and marked for intended location and application.
- J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- K. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- L. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- M. Device Box Dimensions: [4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
- N. Gangable boxes are prohibited.
- O. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, **[Type 1]** **[Type 3R]** with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Plastic.
 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

P. Cabinets:

1. NEMA 250, [Type 1] [Type 3R][Type 4X] [Type 12] galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Manufacturers: Subject to compliance with requirements provide products by one of the following
 - a. Jensen Precast Inc.
 - b. CDR Systems Corporation; Hubbell Power Systems.
 - c. Oldcastle Precast, Inc.; Christy Concrete Products.
 - d. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with [open] [closed] [integral closed] bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, ["ELECTRIC."]. Boxes containing conductors and cables over 600V, the cover shall include permanently engraved name of the utility company, type of utility (e.g. ELECTRIC), DANGER-HIGH VOLTAGE-KEEP OUT" in minimum 1/2" inch size, block letters.
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes [12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long)] and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of [polymer concrete] [reinforced concrete] [cast iron] [hot-dip galvanized-steel diamond plate] [fiberglass].

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. CDR Systems Corporation; Hubbell Power Systems.
 - b. NewBasis.
 - c. Nordic Fiberglass, Inc.
 - d. Oldcastle Precast, Inc.; Christy Concrete Products.
 - e. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
2. Standard: Comply with SCTE 77.
3. Color of Frame and Cover: Gray.
4. Configuration: Designed for flush burial with [open] [closed] [integral closed] bottom unless otherwise indicated.
5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.

6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
7. Cover Legend: Molded lettering, ["ELECTRIC."]. Boxes containing conductors and cables over 600V, the cover shall include permanently engraved name of the utility company (e.g UCSD), type of utility (e.g. ELECTRIC), DANGER-HIGH VOLTAGE-KEEP OUT" in minimum 1/2" inch size, block letters.
8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
9. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 1. Tests of materials shall be performed by an independent testing agency.
 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 1. Exposed Conduit: GRC
 2. Concealed Conduit, Aboveground: EMT, [RNC, Type EPC-40-PVC]. Use EPC-40PVC inside concrete walls and columns only.
 3. Underground Conduit: Type EPC-40-PVC
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
 1. Exposed, Not Subject to Physical Damage: EMT
 2. Exposed, Not Subject to Severe Physical Damage: EMT
 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
 - a. Mechanical rooms.
 - b. Gymnasiums.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 5. Concealed in concrete walls and columns: RNC Type EPC-40-PVC.
 6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations. All FMC shall be steel.
 7. Damp or Wet Locations: GRC.
 8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 [stainless steel] [nonmetallic] in kitchens and damp or wet locations.
 9. Raceways serving light fixtures shall be minimum 3/4" steel flex and shall not exceed 6'.
- C. Minimum Raceway Size: **3/4-inch (21-mm)** trade size for all applications including controls.
- D. Raceways and fittings terminating at equipment, enclosure or pullbox shall have a seal tight fittings at the end of the equipment for a maximum distance of 4'-0".
- E. Raceway Fittings: Compatible with raceways and suitable for use and location.
 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

- 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
- 3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10. Set-Screw fittings are prohibited from use.
- 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- F. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- G. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- H. Install surface raceways only where indicated on Drawings.
- I. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).



3.2 LOW VOLTAGE CONDUIT FILL CAPACITY

- A. Percentage fill to be 40%.
- B. Conduit fill capacity to be 40%.
- C. Extra sleeves for future growth, see the table below.

Conduit to be used	Spare Sleeve or Conduit for future use
1-4	2
5-8	3
9-12	4
13-16	5

- D. Spare conduit lines shall be coordinated per Project basis.

3.3 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- I. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.

4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to GRC before rising above floor.
- J. Stub-ups to Above Recessed Ceilings:
 1. Use EMT, IMC, or RMC for raceways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 250lbs (113 kgs) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Provide acrylic identification tags (2"X4") at each end indicating the source. Cap underground raceways designated as spare above grade alongside raceways in use.
- S. Surface Raceways:
 1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- W. Expansion-Joint Fittings:



1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - d. Attics: 135 deg F (75 deg C) temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations
- Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- BB. Locate boxes so that cover or plate will not span different building finishes.
- CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- EE. Set metal floor boxes level and flush with finished floor surface.
- FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.4 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
 2. Install backfill as specified in Section 31 20 00 "Earth Moving."
 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum

supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 20 00 "Earth Moving."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.5 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances. Top of conduits inside the handhole/box shall be minimum 4 inches above the bottom of the handhole/box.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel (minimum 6 inch high), graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
- D. Install handholes with bottom below frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.8 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.



END OF SECTION 26 05 33

SECTION 26 05 36
CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Ladder cable trays.
 - 2. Single-rail cable trays.
 - 3. Trough cable trays.
 - 4. Fiberglass cable trays.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: For each type of cable tray.
 - 1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
- C. Delegated-Design Submittal: For seismic restraints.
 - 1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and sections, drawn to scale (1/4"=1'-0"), on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
 - 2. Vertical and horizontal offsets and transitions.
 - 3. Clearances for access above and to side of cable trays.
 - 4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
- B. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports. Submit within two (2) weeks of completion of tests.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer to design cable tray supports and seismic bracing.



- B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7
 - 1. The term "withstand" means "cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
 - 2. Component Importance Factor: [1.5].
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 - 1. Source Limitations: Obtain cable trays and components from single manufacturer.
- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles on individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers
 - 1. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 2. Chalfant Manufacturing Company.
 - 3. Cooper B-Line, Inc.
 - 4. Mono-Systems, Inc.
 - 5. MP Husky.
- B. Description:
 - 1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
 - 2. Rung Spacing: 18 inches (450 mm) o.c.
 - 3. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
 - 4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
 - 5. No portion of the rungs shall protrude below the bottom plane of side rails.
 - 6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
 - 7. Minimum Usable Load Depth: **[3 inches (75 mm)] [4 inches (100 mm)] [5 inches (125 mm)] [6 inches (150 mm)]**.
 - 8. Straight Section Lengths: [10 feet (3 m)] except where shorter lengths are required to facilitate tray assembly.
 - 9. Width: 18 inches (450 mm) unless otherwise indicated on Drawings.
 - 10. Fitting Minimum Radius: [12 inches (300 mm)]
 - 11. Class Designation: Comply with NEMA VE 1, [Class 12C
 - 12. Splicing Assemblies: Bolted type using serrated flange locknuts.
 - 13. Hardware and Fasteners: [ASTM F 593 and ASTM F 594 stainless steel, Type 316]
 - 14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.



2.4 MATERIALS AND FINISHES

A. Steel:

1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33
2. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
4. Finish: Mill galvanized before fabrication.
 - a. Standard: Comply with ASTM A 653/A 653M, G90 (Z275).
 - b. Hardware: [Galvanized, ASTM B 633]
5. Finish: Electrogalvanized before fabrication.
 - a. Standard: Comply with ASTM B 633.
 - b. Hardware: Galvanized, ASTM B 633.
6. Finish: Hot-dip galvanized after fabrication.
 - a. Standard: Comply with ASTM A123/A123 M, Class B2.
 - b. Hardware: [Stainless steel, Type 316].
7. Finish: [Powder-coat enamel] paint.
 - a. Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
 - b. Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
 - c. Epoxy-Resin Topcoat: Epoxy, cold-cured, gloss, MPI# 77.
 - d. Hardware: [Stainless steel, Type 316, ASTM F 593 and ASTM F 594].
8. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
9. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

B. Stainless Steel:

1. Materials: Low-carbon, passivated, stainless steel, Type 316L, ASTM F 593 and ASTM F 594.
2. Hardware for Stainless-Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.5 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Covers: Louvered type made of same materials and with same finishes as cable tray.
- C. Barrier Strips: Same materials and finishes as for cable tray.
- D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

- A. Lettering: 1-1/2-inch- (40-mm high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."
- B. Comply with requirements for fasteners in Section 26 05 53 "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to [NEMA FG 1] [NEMA VE 1].

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to [NEMA FG 1] [NEMA VE 2].



- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use four square-neck carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure and install seismic restraints.
- G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems." [Comply with seismic-restraint details according to Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."]
- H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- J. Support bus assembly to prevent twisting from eccentric loading.
- K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- L. Locate and install supports according to [NEMA FG 1] [NEMA VE 2]. Do not install more than one cable tray splice between supports.
- M. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- N. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in [NEMA FG 1] [NEMA VE 2]. Space connectors and set gaps according to applicable standard.
- O. Make changes in direction and elevation using manufacturer's recommended fittings.
- P. Make cable tray connections using manufacturer's recommended fittings.
- Q. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 07 84 13 "Penetration Firestopping."
- R. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- S. Install cable trays with enough workspace to permit access for installing cables.
- T. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
- U. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.
- V. Clamp covers on cable trays installed outdoors with heavy-duty clamps.
- W. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

- C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch (1800-mm) intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."
- D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).
- E. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.
- F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:
 - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 - 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 - 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 - 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
 - 7. Check for improperly sized or installed bonding jumpers.
 - 8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.



9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 26 05 36

SECTION 26 05 43
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct bank.
 - 2. Handholes and boxes.
 - 3. Manholes.
- B. Related Requirements:
 - 1. Section 26 05 26 "Grounding and Bonding of Electrical Systems".

1.3 DEFINITION

- A. RNC: Rigid nonmetallic conduit.
- B. PVC coated GRS: PVC coated Galvanized rigid steel conduit
- C. PVC: Poly Vinyl Chloride
- D. NETA: InterNational Testing Association

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Accessories for manholes, handholes, boxes, and other utility structures.
 - 4. Warning tape.
 - 5. Warning planks.
 - 6. Pull ropes.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Reinforcement details.
 - 3. Frame and cover design and manhole frame support rings.
 - 4. Ladder details.
 - 5. Grounding details.
 - 6. Cable racks, insert. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - 7. Joint details.
- C. Shop Drawings for Factory-Fabricated Manholes, Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Cover design. Include details of factory engraved markings as specified.
 - 3. Grounding details.



4. Cable racks, inserts. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

- A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 2. Drawings shall be signed and sealed by a qualified California registered professional electrical engineer.
- B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858. Certificates shall be signed by manufacturer's structural engineer. Include name and date.
- C. Qualification Data: For professional engineer and testing agency.
- D. Source quality-control test reports.
- E. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Comply with ANSI C2.
- C. Comply with NFPA 70.
- D. Each conduit shall bear manufacturer's trademark and UL label. Conduits and fittings shall be of a single manufacturer. Multiple manufactures for the same material are not acceptable.
- E. Comply with California Electric Code (CEC).

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Deliver precast concrete manholes, handholes and other underground utility structures when the site is ready for installation. Store precast concrete and other factory-fabricated underground utility structures at Project site (if necessary) as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 1. Notify College no fewer than fourteen (14) days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without College Representative's written permission.
 3. Existing electrical service shall be shut down by owner's authorized personnel. Coordinate with owner in advance.

1.9 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities,



underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Furnish cable-support stanchions, arms, insulators and associated fasteners in quantities equal to [5] percent of quantity of each item installed (minimum six of each type).

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Plastic-Coated Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1. Plastic-Coated Rigid Steel Conduit and Fittings: Rigid steel conduit and fittings with an extruded polyvinyl chloride jacket, minimum 40 mils. The jacket shall have high tensile strength, shall be highly resistant to corrosion and shall not oxidize or deteriorate or shrink when exposed to sunlight and weather. The jacket shall be flame retardant and shall not support combustion. The interior of the conduit shall have a urethane coating, minimum 2 mils.
- B. RNC: Heavy wall design; NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B. Make all fittings watertight with solvent-weld recommended by the conduit manufacturer and specifically manufactured for the purpose.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allied Tube and Conduit
 - 2. Cantex, Inc.
 - 3. Lamson & Sessions; Carlon Electrical Products.
 - 4. JM Eagle
- B. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 - 2. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."
 - 3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.
 - a. Color: Red dye added to concrete during batching.
 - b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Christy Concrete Products.
 - 2. Oldcastle Precast Group.
 - 3. Jensen Precast
- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have traffic load rating consistent with that of handhole or box.



1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
3. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
4. Cover Legend: Molded lettering, [NAME OF SERVING UTILITY COMPANY] ["ELECTRIC."] ["TELEPHONE."] ["GROUNDING"] [As indicated for each service.]
5. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
6. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth of [12 inches (300 mm)].
 - b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
7. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
8. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
9. Handholes [12 inches wide by 24 inches long (300 mm wide by 600 mm long)] and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Description: Comply with SCTE 77.
 1. Color: [Gray] [Green].
 2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, [NAME OF SERVING UTILITY COMPANY] ["ELECTRIC."] ["TELEPHONE."] [As indicated for each service.]
 6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
 7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 8. Handholes [12 inches wide by 24 inches long (300 mm wide by 600 mm long)] and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.5 PRECAST MANHOLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Christy Concrete Products.



2. Oldcastle Precast Group.
3. Jensen Precast
- B. Comply with ASTM C 858[with structural design loading as specified in Part 3 "Underground Enclosure Application" Article] and with interlocking mating sections, complete with accessories, hardware, and features.
 1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches (150 mm) or from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls. Windows shall be no less than 12 inches (300 mm) from the floor to avoid water intrusion into the underground ducts.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
- C. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod.
- D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.6 CAST-IN-PLACE MANHOLES

- A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.
- B. Materials: Comply with ASTM C 858 and with Section 033000 "Cast-in-Place Concrete."
- C. Structural Design Loading: As specified in Part 3 "Underground Enclosure Application" Article.

2.7 UTILITY STRUCTURE ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Bilco Company (The).
 2. Christy Concrete Products.
 3. Neenah Foundry Company.
 4. Oldcastle Precast Group.
 5. Underground Devices, Inc.
 6. Utility Concrete Products, LLC.
- B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
 1. Frame and Cover: Weatherproof, [gray cast iron complying with ASTM A 48/A 48M, Class 30B 29 inches (737 mm).
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
 - c. All covers for underground structures to be hinged with a locking mechanism included..
 2. Cover Legend: Cast in. Selected to suit system.



- a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
 - b. Legend: "Name of serving utility company"; "ELECTRIC-HV"; "Manhole/Handhole number as indicated on the drawings" for duct systems with medium-voltage cables.
 - c. Legend: "Name of serving utility company"; "SIGNAL"; "Manhole/Handhole number as indicated on the drawings" for communications, data, and telephone duct systems.
3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
- a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.
- C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.
1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.
- E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (32-mm-) diameter eye, rated [2500-lbf (11-kN)] < minimum tension.
- F. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.
- G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (32 mm) minimum at base.
1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.
- H. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.
- I. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
1. Stanchions: T-section or channel; 2-1/4-inch (57-mm) nominal size; punched with 14 holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.
 2. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (460 mm) with 250-lb (114-kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- J. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
1. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of 9 holes for arm attachment.
 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (508 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.
- K. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts,

metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

- L. Fixed Manhole Ladders: Arranged for attachment to wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, hot-dip galvanized steel. Ladder shall be removable if necessary.
- M. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater required.

2.8 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by a independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40 PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type [EPC-40]-PVC, in concrete-encased duct bank, unless otherwise indicated.
- C. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type [EPC-40]-PVC, in concrete encased duct bank, unless otherwise indicated.
- D. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40 PVC, in concrete encased duct bank, unless otherwise indicated.
- E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40 PVC, in concrete-encased duct bank, unless otherwise indicated.
- F. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: **[RNC, NEMA Type EPC-40-PVC installed in concrete encased duct bank, unless otherwise indicated.**
- G. Underground Ducts Crossing **[Paved Paths] [Walks] [and] [Driveways] [Roadways]** RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less[, Including Telephone, Communications, and Data Wiring]:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, **[H-20]** structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: **[Precast concrete, AASHTO HB 17, H-20] [Polymer concrete, SCTE 77, Tier 15] [Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15] [Fiberglass-reinforced polyester resin, SCTE 77, Tier 15] [High-density plastic, SCTE 77, Tier 15]** structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: **[Precast concrete, AASHTO HB 17, H-10] [Polymer concrete units, SCTE 77, Tier 8] [Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8] [High-density plastic, SCTE 77, Tier 8]** structural load rating.

4. Units Subject to Light-Duty Pedestrian Traffic Only: [**Fiberglass-reinforced polyester resin**] [**High-density plastic**], structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.
- B. Manholes: [**Precast**] [**or**] [**cast-in-place**] concrete.
 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

3.3 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 32 92 00 "Turf and Grasses" and Section 32 93 00 "Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures.

3.4 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius [12.5 feet (4 m)], both horizontally and vertically, at other locations, unless otherwise indicated. For underground ducts containing MV and HV cables, use manufactured long sweep bends with a minimum radius 25 feet (7.5 m) both horizontally and vertically. Number of bends on ducts for HV and MV systems, telephone and signal systems shall not exceed two (2) 90 degrees.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.
 1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid **PVC coated** steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- F. Do not install conduits underneath a building except where the service/feeder/branch circuit conduits enter the building.
- G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- H. Pulling Cord: Install minimum 1/8 inch thick test nylon cord with minimum 250 pounds per foot tensile strength in ducts, including spares.
- I. Concrete-Encased Ducts: Support ducts on duct separators.



1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than [5] spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Encase all feeder ducts in a 3 inch concrete envelope. Extend envelope with 3 inches beyond all external surfaces of all outer most ducts. Do not over pour the concrete.
5. Concrete encasement shall be minimum 3000 psi. All underground ducts containing MV and HV cables (above 600V) shall be encased in red concrete. Concrete shall be premixed during batching with 1-1/2 lbs of red ocher dye per sack of cement.
6. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
7. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
8. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, and 12 inches (300 mm) between power and signal ducts.
9. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated. Minimum depth below grade in all areas shall be 36 inches (900 mm) for underground ducts containing MV and HV ducts.
10. Stub-Ups: Use manufactured PVC coated rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple PVC coated steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
11. Warning Tape: Bury warning tape approximately 12 inches (300 mm) below grade above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

J. Direct-Buried Duct Banks:

1. Not Permitted.



3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Cast-in-Place Manhole Installation:
 - 1. Finish interior surfaces with a smooth-troweled finish.
 - 2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches (38 to 50 mm) thick, arranged as indicated.
 - 3. Cast-in-place concrete, formwork, and reinforcement are specified in Section 03 30 00 "Cast-in-Place Concrete."
- B. Precast Concrete Handhole and Manhole Installation:
 - 1. Comply with ASTM C 891, unless otherwise indicated.
 - 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 - 3. Unless otherwise indicated, support units on a level bed of 12 inches thick crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevations:
 - 1. Manhole Roof: Install with rooftop at least 15 inches (380 mm) below finished grade.
 - 2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. In other areas, set manhole frames 1 inch (25 mm) above finished grade.
 - 3. Install handholes with bottom below the frost line, below grade.
 - 4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
 - 5. Where indicated, cast handhole cover frame integrally with handhole structure.
- D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- E. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 - 1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 - 2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in [Section 07 13 53 "Elastomeric Sheet Waterproofing."] [Section 07 13 54 "Thermoplastic Sheet Waterproofing."] After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
- G. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 07 11 13 "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, [and] cable arms, [and] insulators, [as] required for installation and support of cables and conductors and as indicated.
- I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (98 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.



SECTION 26 05 44
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Submittals:
 - 1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
 - 2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.



1. Manufacturers: Subject to compliance with requirements, products by one of the following manufacturers
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: [Stainless steel] of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers
 - a. Presealed Systems.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 2. Sealant shall have VOC content of <Insert value> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:



- a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide [1/4-inch (6.4-mm)] annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm)] above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install PVC Coated cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44



SECTION 26 05 48
VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

- A. All general conditions and supplementary general conditions apply to the work of this Section. Provide and perform the vibration isolation work as indicated, specified, and required.
- B. Principal work included in this Section:
 - 1. Flexible conduits at motor connections

1.2 VIBRATION ISOLATION AND NOISE CONTROL REQUIREMENTS

- A. Flexible Electrical Connections:
 - 1. At connections to motors or other vibrating equipment

1.3 DEFINITIONS

- A. The IBC: International Building Code.
- B. CC-ES: ICC-Evaluation Service.
- C. California Building Code (CBC).

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic restraints are to be based upon the prevailing building code.

PART 2 - PRODUCTS

2.1 FLEXIBLE CONNECTIONS

- A. For conduit under 1 inch OD: Use "flexible" conduit with slack at least 3 feet or 15 diameters long, whichever is the longer or provide a flexible coupling as defined above.

PART 3 - EXECUTION

3.1 INSTALLATION OF VIBRATION ISOLATION DEVICES:

- A. Install vibration isolators per manufacturer's directions.
- B. Flexible electrical connections.
 - 1. Electrical connections to all vibration isolated equipment shall be flexible, and made a way which does not impair or restrain the function of the aforementioned vibration isolation system.
- C. All vibration isolation devices, including auxiliary steel bases shall be designed and furnished by a single manufacturer or supplier, who will be responsible for adequate coordination of all phases of this work.
- D. Vibration Isolation Hangers
 - 1. The isolators shall be installed with the isolator hanger box as close as possible to the structure.

END OF SECTION 26 05 48

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's catalog cut sheets for each electrical identification product indicated.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969. Adhesive type labels shall be used for only applications indicated in this section.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

- B. Colors for Raceways Carrying Feeders and Circuits at 600 V or Less:
 - 1. Black letters on an orange field
 - 2. Legend: Indicate voltage and system or service type.
- C. Colors for Raceways Carrying Feeders and Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING."
- D. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.
- E. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- G. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers diagonally over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stop stripes at legends.
- H. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- I. Write-On Tags: Polyester tag, [0.015 inch (0.38 mm)] thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
 - 3. Use write-on tags for temporary service only if specified on the documents.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.
- B. Colors for Cables Carrying Circuits at 600 V and Less:
 - 1. Black letters on an orange field
 - 2. Legend: Indicate voltage and system or service type.
- C. Colors for Cables Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER HIGH VOLTAGE WIRING."
- D. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.
- E. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.
- F. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

- B. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.
- C. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil- (0.08-mm-) thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the cable diameter such that the clear shield overlaps the entire printed legend.
- D. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.
- E. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- F. Write-On Tags: Polyester tag, [0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- G. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.
- H. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR AND CABLES IDENTIFICATION MATERIALS

- A. Color coding of conductors: Provide color coded insulation by conductor manufacturer. Coordinate with Division 26, Section "Low Voltage Electrical Power Conductors and Cables". If permitted by owner's representative, install color coding conductor tape for temporary installations only.
- B. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- C. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil- (0.08-mm-) thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the conductor diameter such that the clear shield overlaps the entire printed legend.
- D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.
- F. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around conductor it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.
- G. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- H. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable. Provide for temporary installations only.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Labels for Tags: Self-adhesive label, machine-printed with permanent, waterproof, black ink recommended by printer manufacturer, sized for attachment to tag.
- I. Medium voltage cable tag: Laminated Micrata type, 5" x 3½", nameplates engraved with 5/32-inch high black letters on white background for normal power and red letters on white background for emergency power.



1. Feeder or circuit number.
2. Size of MV cable and equipment grounding conductor.
3. Point of origin and point of destination.
4. Date of installation
5. Name of installing contractor

J. Provide tags on each pull rope of spare conduits showing starting point and end point of spare conduits.

2.5 FLOOR MARKING TAPE

- A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with **[black and white]** **[yellow and black]** stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: CAUTION-BURIED ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: CAUTION-BURIED TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag: Type I:

1. Pigmented polyolefin, bright-colored, [continuous-printed on one side with the inscription of the utility,]compounded for direct-burial service.
2. Thickness: 4 mils (0.1 mm).
3. Weight: 18.5 lb/1000 sq. ft. (9.0 kg/100 sq. m).
4. 3-Inch (75-mm) Tensile According to ASTM D 882: 30 lbf (133.4 N), and 2500 psi (17.2 MPa).

D. Tag: [Type II]:

1. Multilayer laminate consisting of high-density polyethylene scrim coated with pigmented polyolefin, bright-colored, [continuous-printed on one side with the inscription of the utility,]compounded for direct-burial service.
2. Thickness: 12 mils (0.3 mm).
3. Weight: 36.1 lb/1000 sq. ft. (17.6 kg/100 sq. m).
4. 3-Inch (75-mm) Tensile According to ASTM D 882: 400 lbf (1780 N), and 11,500 psi (79.2 MPa).

E. Tag: Type ID

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Overall Thickness: 5 mils (0.125 mm).
3. Foil Core Thickness: 0.35 mil (0.00889 mm).
4. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
5. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf (311.3 N), and 4600 psi (31.7 MPa).

F. Tag: Type IID

1. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

2. Overall Thickness: 8 mils (0.2 mm).
3. Foil Core Thickness: 0.35 mil (0.00889 mm).
4. Weight: 34 lb/1000 sq. ft. (16.6 kg/100 sq. m).
5. 3-Inch (75-mm) Tensile According to ASTM D 882: 300 lbf (1334 N), and 12,500 psi (86.1 MPa).

2.7 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 3. Nominal size, 7 by 10 inches (180 by 250 mm).
- D. Metal-Backed, Butyrate Warning Signs:
 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 3. Nominal size, 10 by 14 inches (250 by 360 mm).
- E. Warning label and sign shall include, but are not limited to, the following legends:
 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM) for electrical service 600V or less."
 3. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 60 INCHES (915 MM) for electrical service above 600V and upto 15000V."
 4. High Voltage Equipment Warning "DANGER - HIGH VOLTAGE - KEEP OUT".
 5. Provide other warning labels and signs as required by applicable code and regulation.

2.8 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 1. Engraved legend with black letters on white face.
 2. Punched or drilled for mechanical fasteners.
 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
- C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.9 EQUIPMENT IDENTIFICATION LABELS

- A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm) except designation which will be in 1/2 inch letters unless otherwise indicated.



- C. Stenciled Legend: Provide stenciled labels to identify major equipment numbers (e.g. transformers, MV switches etc) indicated on drawings, in nonfading, waterproof, black ink or paint. Minimum letter height shall be [2 inch (50 mm)] <Insert dimension>. Verify letter height with Owner's representative prior to start of work. Stencil labels shall be provided in addition to engraved laminated labels specified in para D above.
- D. Labels shall include the following information. Color of nameplate shall be black for equipment connected to normal power, red for equipment connected to emergency power, and blue for equipment connected to Un-interruptible Power Supply. Color of letters shall be white.
 - 1. Panel or equipment designation.
 - 2. Rating: Volt, Amps, No. of phase and wires, horsepower, etc.
 - 3. AIC Rating (RMS Symmetrical Amps).
 - 4. Fed from information.
 - 5. Manufacturer Shop Order number.
 - 6. Date of Installation.
 - 7. Other information as requested by Owner.
- E. For medium-voltage switchgear:
 - 1. Use 1 inch to identify equipment designation
 - 2. Use 3/4 inch to identify voltage rating and source
 - 3. Use 1/2 inch to identify individual feeder breakers and buckets
 - 4. Use 1/4 inch to identify control switches, indicating lights, and other miscellaneous devices on the bucket door.
- F. Adhesive labels and nameplates are not acceptable.

2.10 WIRING DEVICES LABELS

- A. Identify wiring devices with heavy duty clear vinyl polyester tape "Weber" unless otherwise indicated. Provide labels on the device cover plate made of non-metallic materials. Color of letters shall be black for device connected to normal power, color of letters shall be red for device connected to emergency power. Labels shall be printed, flexible, self-adhesive type. In addition write the circuit no. (e.g. 1PA-2) on the inside of the device cover plate of non-metallic material using a permanent marker.
- B. For stainless steel cover plates, engrave information on the device cover plate.
- C. Device (receptacles, switches etc.) label shall include panel designation, circuit number and room number.
- D. Lighting devices including gateways, controller, bridges, sensors, switches shall have room number, circuit number, controller number and location.

2.11 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
 - 1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

2.12 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.
- G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- I. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 1. Outdoors: UV-stabilized nylon.
 2. In Spaces Handling Environmental Air: Plenum rated.
- J. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply to the following finished surfaces:
 1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
 2. Wall surfaces directly external to raceways concealed within wall.
 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- B. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: [Self-adhesive vinyl labels. Install labels at 10-foot (3-m) maximum intervals.



- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label bands. Install labels at 10-foot (3-m) maximum intervals.
- D. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. Emergency Power
 - 2. Power
 - 3. UPS
- E. Power-Circuit Conductor Identification, 600V or less: Provide factory color coded conductors as indicated in Division 26 "Low Voltage Power Conductors and Cables". Color coding tape may be field applied (if specified on the documents or permitted in writing by Owner's representative) to identify phase conductors in vaults, pull and junction boxes, manholes, handholes and other locations where conductors are spliced and terminated. For existing buildings, indicate whether requirements apply to both old and new wiring or to new wiring only. Below applies only to phase conductors. Color-coding of grounded and grounding conductors is dictated by NFPA 70. Verify that Owner does not require another color-code. Colors for factory-assembled cable, such as MC and AC, must match colors listed in first paragraph below.
 - 1. Color-Coding for Phase Identification, 600 V or Less: Use colors listed below for ungrounded service, feeders and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral : White
 - 5) Ground Green
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral : Grey
 - 5) Ground : Green
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- F. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use Laminated Micrata type, 5" x 3½", nameplates engraved with 5/32-inch high black letters on white background for normal power and red letters on white background for emergency power. Include the circuit designation to match owner's existing standard.
- G. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use **[self-adhesive vinyl labels]** with the conductor or cable designation, origin, and destination.
- I. Control-Circuit Conductor Termination Identification: For identification at terminations provide heat-shrink preprinted tubes with the conductor designation.



- J. Conductors to Be Extended in the Future: Attach **[write-on tags]** **[marker tape]** to conductors and list source.
- K. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- L. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - 1. Limit use of underground-line warning tape to direct-buried cables.
 - 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
 - 3. During backfilling of trenches install continuous underground-line warning tape directly above the line at 12 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
- M. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- N. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage with black letters on an orange background.
 - 3. Apply to exterior of door, cover, or other access.
 - 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- O. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- P. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer, load shedding.
- Q. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label [Stenciled legend 4 inches (100 mm) high].
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 - 2. Equipment to Be Labeled:



- a. Panelboards: Typewritten directory of circuits in the location provided by panel board manufacturer. Panelboard identification shall be engraved laminated acrylic label.
- b. Enclosures, electrical, telecom, alarm and communication system cabinets.
- c. Access doors and panels for concealed electrical items.
- d. Switchgear.
- e. Switchboards.
- f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panel boards or equipment supplied by the secondary. For pad-mount transformers- indicate type and size of fuses on a separate 3" X 5" plastic laminated label and install on the inside surface of the door of the transformer.
- g. Substations.
- h. Emergency power system boxes and enclosures.
- i. Motor-control centers.
- j. Enclosed switches including ATS.
- k. Enclosed circuit breakers.
- l. Enclosed controllers.
- m. Variable-speed controllers.
- n. Push-button stations.
- o. Power transfer equipment including transfer switches.
- p. Contactors.
- q. Remote-controlled switches, dimmer modules, and control devices.
- r. Battery-inverter units.
- s. Battery racks.
- t. Power-generating units.
- u. Monitoring and control equipment.
- v. UPS equipment.
- w. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

END OF SECTION 26 05 53



SECTION 26 05 72
OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of Medium Voltage (MV) and Low Voltage (LV) circuit protective devices.

1.2 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. RMS: Root Mean Square
- E. SCCR: Short-circuit current rating.
- F. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.3 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form on a CD and include one print copy in a three ring binder.
 - 1. Short-circuit study input data, including completed computer program input data sheets.
 - 2. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified California registered professional engineer.
 - a. Submit study report for action prior to receiving final approval of the power distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from University Representative for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
 - b. Revised single-line diagram, reflecting field investigation results and results of short-circuit study.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Short-Circuit Study Software Developer, Short-Circuit Study Specialist and Field Adjusting Agency.
- B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.5 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Short-Circuit Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

- C. Short-Circuit Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, registered and licensed in State of California with minimum ten years experience in performing OC Protective Device Short Circuit Studies for facilities of similar size and scope. The study specialist shall be located within 75 miles radius of the project and be available to meet on short notice. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated at site, that is a member company of the InterNational Electrical Testing Association (NETA) and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

- A. ETAP Program.
- B. Comply with IEEE 399 and IEEE 551.
- C. Analytical features of fault-current-study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. Executive summary.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following for normal and emergency/standby power system:
 - 1. MV and LV Protective device designations and ampere ratings including fuses.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
 - 6. Variable Speed Drives
 - 7. UPS and Central battery Inverters
 - 8. Motor Control Panels
 - 9. Motor controllers
- D. Comments and recommendations for system improvements, where needed.
- E. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices shown on single line diagrams and compare to short-circuit ratings. Include existing devices which are part of the primary electrical system to remain, and are to be reconnected to the new equipment under this project.
 - 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 - 3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.



- F. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.
- G. Short-Circuit Study Output:
 - 1. Medium Voltage and Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.
 - 2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
 - 3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2, 3, 5, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2, 3, 5, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Obtain all data necessary for the conduct of the study.
 - 1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of University's Representative.
 - 2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 - 3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.
 - 4. For existing equipment reconnected to a new power source.
- B. Gather and tabulate the following input data to support the short-circuit study. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
 - 1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Obtain electrical power utility impedance at the service.
 - 3. Power sources and ties.



4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices as follows:
 1. To normal system low-voltage load buses where fault current is 10 kA or less and to mechanical equipment control panel where fault current is 5kA or less.
 2. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- F. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- G. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:
 1. Electric utility's supply termination point.
 2. Incoming switchgear.
 3. Unit substation primary and secondary terminals.
 4. Medium and Low-voltage switchgear.
 5. Motor-control centers and motor controllers.
 6. Variable Frequency Drives.
 7. Control panels.
 8. Standby generators and automatic transfer switches.
 9. Branch circuit panelboards.
 10. Disconnect switches and Circuit Breakers.

3.3 ADJUSTING

- A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

3.4 DEMONSTRATION

- A. Train University's operating and maintenance personnel in the use of study results.

END OF SECTION 26 05 72

SECTION 26 05 73
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes computer-based, fault-current, overcurrent protective device coordination studies and arc flash study. Protective devices shall be set based on results of the protective device coordination study.
 - 1. Coordination of series-rated devices is permitted where indicated on Drawings.

1.3 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form if requested by the architect/engineer.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For coordination-study specialist.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

1.5 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
- B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - 1. CGI CYME.



2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc.
6. ETAP

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 1. Product Data for overcurrent protective devices specified in other electrical Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Impedance of utility service entrance.
 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.

- b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
- c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
- d. Generator thermal-damage curve.
- e. Ratings, types, and settings of utility company's overcurrent protective devices.
- f. Special overcurrent protective device settings or types stipulated by utility company.
- g. Time-current-characteristic curves of devices indicated to be coordinated.
- h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 - 1. Switchgear and switchboard bus.
 - 2. Medium-voltage controller.
 - 3. Motor-control center.
 - 4. Distribution panelboard.
 - 5. Branch circuit panelboard.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with [IEEE 141] [IEEE 241] and IEEE 242.
 - 1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.
 - 2. Medium-Voltage Circuit Breakers: IEEE C37.010.
 - 3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 - 4. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
 - 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
 - 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium- and high voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
- F. Equipment Evaluation Report:
 - 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with [IEEE 141] [IEEE 241] [IEEE 242] recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- G. Completed data sheets for setting of overcurrent protective devices.

END OF SECTION 26 05 73

SECTION 26 05 74
OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment for normal and emergency/standby power systems shown on the drawings.

1.2 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.3 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form and include a print copy in a binder.
 - 1. Arc-flash study input data, including completed computer program input data sheets.
 - 2. Arc-flash study report; signed, dated, and sealed by a qualified California registered professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from College Representative for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Arc-Flash Study Software Developer, Arc-Flash Study Specialist and Field Testing and Adjusting Agency.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
- B. Operation and Maintenance Procedures: In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," provide maintenance procedures for use by College's authorized personnel that comply with requirements in NFPA 70E.

1.6 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.



- B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed and registered in California. The study specialist shall have at least 10 years' experience in performing arc flash study for facilities of similar size and scope. The specialist shall be located within 75 miles' radius of the project and available to meet on short notice. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- D. Testing and Adjusting Agency
 - 1. Field Testing and Adjusting Agency Qualifications: Testing and adjusting agency shall be an independent company; with the experience and capability to test and adjust overcurrent protective devices as indicated. The agency shall have been a member of NETA for a minimum of last ten (10) years and has permanent in-house testing engineers and technicians involved with testing and adjusting of overcurrent protective devices similar to those specified on this project.
 - 2. Testing and adjusting company shall be located with 50 miles radius of the project.
 - 3. Testing and Adjusting Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
 - 4. Field Testing and adjusting technician and supervisor shall have minimum ten (10) years' experience in field testing and adjusting of Overcurrent Protective Devices of the type and rating similar to those devices to be tested on this project.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Software Developers:
 - 1. ETAP Program
 - 2. Comply with IEEE 1584 and NFPA 70E.
- B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings for normal and emergency/standby power system devices.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output: As specified in "Short Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 72 "Overcurrent Protective Device Short-Circuit Study."
- F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 26 05 73 "Overcurrent Protective Device Coordination Study."
- G. Arc-Flash Study Output:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:



- a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2, 3, 5, and 8 cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2, 3, 5, and 8 cycle circuit breakers rated on a total basis.
- H. Incident Energy and Flash Protection Boundary Calculations:
1. Arcing fault magnitude.
 2. Protective device clearing time.
 3. Duration of arc.
 4. Arc-flash boundary.
 5. Working distance.
 6. Incident energy.
 7. Hazard risk category.
 8. Recommendations for arc-flash energy reduction.
- I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems." Produce a 3.5-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.
- B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 1. Location designation.
 2. Nominal voltage.
 3. Flash protection boundary.
 4. Hazard risk category.
 5. Incident energy.
 6. Working distance.
 7. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.
- D. Labels shall be suitable for indoor or outdoor environments for a minimum period of 5 years.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies:
 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 72 "Overcurrent Protective Device Short-Circuit Study."
 2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 26 05 73 "Overcurrent Protective Device Coordination Study."



- C. Calculate maximum and minimum contributions of fault-current size.
 - 1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
 - 2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 125 kVA.
- F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.
- G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond three to five cycles.
 - 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
- H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
 - 1. When the circuit breaker is in a separate enclosure.
 - 2. When the line terminals of the circuit breaker are separate from the work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.
 - 1. Verify completeness of data supplied on the one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to the attention of College Representative.
 - 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 - 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.
- B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
 - 1. Product Data for overcurrent protective devices shown and specified in other Sections of this specifications . Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Obtain electrical power utility impedance at the service.
 - 3. Power sources and ties.
 - 4. Short-circuit current at each system bus, three phase and line-to-ground.
 - 5. Full-load current of all loads.
 - 6. Voltage level at each bus.
 - 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.



8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

3.4 LABELING

- A. Apply one arc-flash label for above 600VAC, 600V ac, 480V ac, and applicable 208V ac equipment including each of the following locations:
 1. Motor-control center.
 2. Low-voltage switchboard.
 3. Switchgear.
 4. Medium-voltage switch.
 5. Panelboards
 6. Motor controllers including VFDs
 7. Disconnects
 8. Control panel.

3.5 APPLICATION OF WARNING LABELS

- A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.6 DEMONSTRATION

- A. Engage the Arc-Flash Study Specialist to train College's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 26 05 74

SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. System specific commissioning
 - 2. Electrical systems to be commissioned are as follows:
 - a. Electrical Switchgear
 - b. Electrical Panel boards
 - c. Electrical Transformers
 - d. Grounding Systems
 - e. Electrical Power Metering Systems
 - f. Interface with building energy management system

PART 2 - EXECUTION

2.1 PRE-FUNCTIONAL CHECKLIST

- A. Only the sample checklists are provided in this section as an indication of the format and rigor of the required pre-functional checklists and documentation (refer to Section 26 08 00 - Exhibit A). Though not developed specifically for this project, they show the extent of checks involved associated with typical installations. Actual Pre-Functional Checklist shall be prepared by the Commissioning Authority (CA) upon review of all the contractor submittals, including manufacturer's installation instructions.
- B. These checklists do not take the place of the manufacturer's recommended checkout and start-up procedures or report or those used by the Testing Agency.
- C. Regardless of whether the CA includes them or not, checks, inspections, safety measures, quality control measures and start-up procedures recommended by the manufacturer shall be implemented by the Contractor prior to initiation of the commissioning activity.
- D. The Commissioning Coordinator (CC) employed by the Contractor shall be responsible for directing all Pre-Functional Check lists provided by the CA. The CC shall engage subcontractors and vendors service representatives with expertise in the specific equipment or system to determine whether the equipment or system passes the checks detailed in the Pre-Functional Checklist.
- E. CC shall communicate the actual schedule for the execution of the Pre-Functional Checks to the CA.
- F. The Commissioning Authority (CA) may choose to participate in the inspection of items along with the Contractor and his specialty subcontractors and vendors, including the Testing Agency. In addition, CA reserves the right to inspect any or all of the items on his own in order to satisfy that the installation conforms to the design objectives and the system is ready for Functional Testing.

2.2 ACCEPTANCE TESTING

- A. Contractor shall engage the services of a recognized corporately and financially independent testing firm for the purpose of performing inspections and tests on all new electrical equipment supplied in this contract and on existing equipment affected by the new addition or as specified.
- B. Prior to energization, the Independent Testing Firm shall perform visual and mechanical inspections and electrical tests on all newly installed equipment supplied within this contract. All inspections and tests shall be in accordance with the indicated test standards as specified in Division 26 and the manufacturer's instruction manuals.
- C. Upon completion of equipment Acceptance Testing, the Independent Testing Firm shall perform system function tests on all new electrical equipment supplied within this contract and existing affected equipment to prove the correct interaction of all sensing, processing and action devices and evaluate the performance of all integral components and their functioning as a complete unit to effect the design result.



- D. Manufacturers recommended test to be done on switchgear and GFCI protection equipment before the 1 year warranty expiration shall be done by the contractor at their expense before the termination of the warranty period.
- E. Any deficiencies identified by initial Acceptance Testing rectified by the Contractor and retested by the Independent Testing Firm at Contractors expense until specified requirements are met. Final acceptance of the electrical power system by the Engineer is contingent upon the satisfactory compliance of the Acceptance Testing.

END OF SECTION 26 08 00

SECTION 26 09 13
ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes the following for monitoring of electrical power system:
 - 1. PC-based workstation(s) and software.
 - 2. Communication network and interface modules for LONWORKS IEEE 802.3 data transmission protocols.

1.3 DEFINITIONS

- A. Ethernet: Local area network based on IEEE 802.3 standards.
- B. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
- C. HTML: Hypertext markup language.
- D. I/O: Input/output.
- E. KY Pulse: A term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay changing status in response to the rotation of the disk in the meter.
- F. LAN: Local area network; sometimes plural as "LANs."
- G. LCD: Liquid crystal display.
- H. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.
- I. LONWORK: An open protocol for exchange of process data.
- J. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- K. PC: Personal computer; sometimes plural as "PCs."
- L. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
- M. RS-485: A TIA standard for multipoint communications using two twisted-pairs.
- N. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- O. THD: Total harmonic distortion.
- P. UPS: Uninterruptible power supply; used both in singular and plural context.
- Q. WAN: Wide area network.
- R. WAP: Wireless area point.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Outline Drawings: Indicate arrangement of components and clearance and access requirements.



2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
5. Surge Suppressors: Data for each device used and where applied.

1.5 INFORMATIONAL SUBMITTALS

- A. Informational Submittals:
 1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals. Include the following:
 1. Operating and applications software documentation.
 2. Software licenses.
 3. Software service agreement.
 4. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, and drivers for all installed hardware. Provide separately for each PC.
 5. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files of the hard-copy submittal.
- B. Software and Firmware Operational Documentation:
 1. Self-study guide describing the process for setting equipment's network address; setting Owner's options; procedures to ensure data access from any PC on the network, using a standard Web browser; and recommended firewall setup.
 2. Software operating and upgrade manuals.
 3. Software Backup: On a thumb drive complete with Owner-selected options.
 4. Graphic file and printout of graphic screens and related icons, with legend.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Manufacturer Qualifications: A firm experienced in manufacturing power monitoring and control equipment similar to that indicated for this Project and with a record of successful in-service performance.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for 1 year.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within 1 year from date of Substantial Completion. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Match existing college metering standard. No exceptions, or no equals.



2.2 FUNCTIONAL DESCRIPTION

- A. Instrumentation and Recording Devices: Monitor and record load profiles and chart energy consumption patterns.
 - 1. Calculate and Record the Following:
 - a. Load factor.
 - b. Peak demand periods.
 - 2. Measure and Record Metering Data for the Following:
 - a. Electricity.
- B. Software: Calculate allocation of utility costs.
 - 1. Automatically Import Energy Usage Records to Allocate Energy Costs for the Following:
 - a. At least 15 departments.
 - b. At least 30 tenants.
 - c. At least 5 processes.
 - d. At least 100 buildings.
- C. Power Quality Monitoring: Identify power system anomalies and measure, display, and record trends and alarms of the following power quality parameters:
 - 1. Voltage regulation and unbalance.
 - 2. Continuous three-phase rms voltage.
 - 3. Periodic max./min./avg. voltage samples.
 - 4. Harmonics.
 - 5. Voltage excursions.
- D. System: Report equipment status.

2.3 SYSTEM REQUIREMENTS

- A. Monitoring and Control System: Include with its operating system and application software, connected to the University's Energy Management System.
- B. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.
 - 1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 26 43 13 "Surge Protection for Low-Voltage Electrical Power Circuits."
 - 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.
- C. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.
- D. EMS Interface: Provide factory-installed hardware and software to enable the college building automation standard EMS to monitor, display, and record data for use in processing reports.
 - 1. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption kilowatt-hours and power factor.
 - 2. Communication interface shall enable the EMS operator to remotely monitor meter information from an EMS operator workstation. Control features and monitoring points displayed locally at metering panel shall be available through the EMS.

2.4 OPERATING SYSTEM

- A. Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously. Software shall include interactive graphics client and shall be Web enabled. Portable computers shall not require any software except for an Internet browser to provide connectivity and full functionality. Include a firewall recommended by manufacturer.

2.5 APPLICATIONS SOFTWARE

- A. Basic Requirements:



1. Fully compatible with and based on the approved operating system.
 2. Password-protected operator login and access; three levels, minimum.
 3. Password-protected setup functions.
 4. Context-sensitive online help.
 5. Capability of creating, deleting, and copying files; and automatically maintaining a directory of all files, including size and location of each sequential and random-ordered record.
 6. Capability for importing custom icons into graphic views to represent alarms and I/O devices.
 7. Automatic and encrypted backups for database and history; automatically stored at central control PC and encrypted with a nine-character alphanumeric password, which must be used to restore or read data contained in backup.
 8. Operator audit trail for recording and reporting all changes made to user-defined system options.
- B. Data Formats:
1. User-programmable export and import of data to and from commonly used Microsoft Windows spreadsheet, database, billing, and other applications; using dynamic data exchange technology.
 2. Option to convert reports and graphics to HTML format.
 3. Interactive graphics.
 4. Option to send preprogrammed or operator designed e-mail reports.
- C. Metered Data: Display metered values in real time.
- D. Equipment Documentation: Database for recording of equipment ratings and characteristics; with capability for graphic display on monitors.
- E. Graphics: Interactive color-graphics platform with pull-down menus and mouse-driven generation of power system graphics.
- F. User-Defined Monitoring and Control Events: Display and record with date and time stamps accurate to 0.1 second, and including the following:
1. Operator log on/off.
 2. Attempted operator log on/off.
 3. All alarms.
 4. Equipment operation counters.
 5. Out-of-limit, pickup, trip, and no-response events.
- G. Trending Reports: Display data acquired in real-time from different meters or devices, in historical format over user-defined time; unlimited as to interval, duration, or quantity of trends.
1. Spreadsheet functions of sum, delta, percent, average, mean, standard deviation, and related functions applied to recorded data.
 2. Charting, statistical, and display functions of standard Windows-based spreadsheet.
- H. Alarms: Display and record alarm messages from discrete input and controls outputs, according to user programmable protocol.
1. Functions requiring user acknowledgment shall run in background during computer use for other applications and override other presentations when they occur.
- I. Waveform Data: Display and record waveforms on demand or automatically on an alarm or programmed event. Include the graphic displays of the following, based on user-specified criteria:
1. Phase voltages, phase currents, and residual current.
 2. Overlay of three-phase currents, and overlay each phase voltage and current.
 3. Waveforms ranging in length from 2cycles to 5 minutes.
 4. Disturbance and steady-state waveforms up to 512 points per cycle.
 5. Transient waveforms up to 83,333 points per cycle on 60-Hz base.
 6. Calculated waveform, based on recorded data, on a minimum of four cycles of data of the following:
 - a. THD
 - b. RMS magnitudes.
 - c. Peak values.



- d. Crest factors.
- e. Magnitude of individual harmonics.
- J. Data Sharing: Allow export of recorded displays and tabular data to third-party applications software.
 - 1. Tabular data shall be in the comma-separated values.
- K. Reporting: User commands initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
 - 1. Print a record of user-defined alarm, supervisory, and trouble events on workstation printer.
 - 2. Sort and report by device name and by function.
 - 3. Report type of signal (alarm, supervisory, or trouble), description, date, and time of occurrence.
 - 4. Differentiate alarm signals from other indications.
 - 5. When system is reset, report reset event with same information concerning device, location, date, and time.
- L. Display Monitor:
 - 1. Backlighted LCD to display metered data with touch pad selecting device.
 - 2. Display 2 values on one screen at same time.

2.6 COMMUNICATION COMPONENTS AND NETWORKS

- A. Network Configuration: High-speed, multi-access, open nonproprietary, industry standard communication protocol; LONWORKS.

2.7 POWER MONITORS

- A. Separately mounted, permanently installed instrument for power monitoring and control, complying with UL 1244.
 - 1. Enclosure: NEMA 250, Type 1.
- B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - 1. Indoor installation in non-air-conditioned spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
- C. rms Real-Time Measurements:
 - 1. Current: Each phase, neutral, average of three phases, percent unbalance.
 - 2. Voltage: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases, line-to-neutral percent unbalance.
 - 3. Power: Per phase and three-phase total.
 - 4. Reactive Power: Per phase and three-phase total.
 - 5. Apparent Power: Per phase and three-phase total.
 - 6. Power Factor: Per phase and three-phase total.
 - 7. Displacement Power Factor: Per phase and three-phase total.
 - 8. Frequency.
 - 9. THD: Current and voltage.
 - 10. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
 - 11. Incremental Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
 - 12. Conditional Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
- D. Demand Current Calculations, per Phase, Three-Phase Average and Neutral:
 - 1. Present.
 - 2. Running average.
 - 3. Last completed interval.
 - 4. Peak.
- E. Demand Real Power Calculations, Three-Phase Total:
 - 1. Present.
 - 2. Running average.



3. Last completed interval.
 4. Predicted.
 5. Peak.
 6. Coincident with peak kVA demand.
 7. Coincident with kVAR demand.
- F. Demand Reactive Power Calculations, Three-Phase Total:
1. Present.
 2. Running average.
 3. Last completed interval.
 4. Predicted.
 5. Peak.
 6. Coincident with peak kVA demand.
 7. Coincident with kVAR demand.
- G. Demand Apparent Power Calculations, Three-Phase Total:
1. Present.
 2. Running average.
 3. Last completed interval.
 4. Predicted.
 5. Peak.
 6. Coincident with peak kVA demand.
 7. Coincident with kVAR demand.
- H. Average Power Factor Calculations, Demand Coincident, Three-Phase Total:
1. Last completed interval.
 2. Coincident with kW peak.
 3. Coincident with kVAR peak.
 4. Coincident with kVA peak.
- I. Power Analysis Values:
1. THD, Voltage and Current: Per phase, three phase, and neutral.
 2. Displacement Power Factor: Per phase, three phase.
 3. Fundamental Voltage, Magnitude and Angle: Per phase.
 4. Fundamental Currents, Magnitude and Angle: Per phase.
 5. Fundamental Real Power: Per phase, three phase.
 6. Fundamental Reactive Power: Per phase.
 7. Harmonic Power: Per phase, three phase.
 8. Phase rotation.
 9. Unbalance: Current and voltage.
 10. Harmonic Magnitudes and Angles for Current and Voltages: Per phase, up to 31st harmonic.
- J. Power Demand Calculations: According to one of the following calculation methods, selectable by the user:
1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
 2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
 - a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
 - b. Fixed block that calculates demand at end of the interval.
 - c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
 3. Demand Calculation Initiated by a Synchronization Signal:



- a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
 - b. Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
 - c. Demand can be synchronized with clock in the power meter.
- K. Sampling:
1. Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.
 2. Power monitor shall provide continuous sampling at a rate of 128 samples per cycle on all voltage and current channels in the meter.
- L. Minimum and Maximum Values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:
1. Line-to-line voltage.
 2. Line-to-neutral voltage.
 3. Current per phase.
 4. Line-to-line voltage unbalance.
 5. Line-to-neutral voltage unbalance.
 6. Power factor.
 7. Displacement power factor.
 8. Total power.
 9. Total reactive power.
 10. Total apparent power.
 11. THD voltage L-L.
 12. THD voltage L-N.
 13. THD current.
 14. Frequency.
- M. Harmonic Calculation: Display and record the following:
1. Harmonic magnitudes and angles for each phase voltage and current through 31 harmonic. Calculate for all three phases, current and voltage, and residual current. Current and voltage information for all phases shall be obtained simultaneously from same cycle.
 2. Harmonic magnitude reported as a percentage of the fundamental or as a percentage of rms values, as selected by user.
- N. Current and Voltage Ratings:
1. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
 2. Withstand ratings shall not be less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
 3. Designed for use with voltage inputs from standard instrument potential transformers with a 120-V secondary.
- O. Accuracy:
1. Comply with ANSI C12.20, Class 0.5; and IEC 60687, Class 0.5 for revenue meters. Accuracy from Light to Full Rating shall meet the following criteria:
 - a. Power: Accurate to 0.25 percent of reading, plus 0.025 percent of full scale.
 - b. Voltage and Current: Accurate to 0.075 percent of reading, plus 0.025 percent of full scale.
 - c. Power Factor: Plus or minus 0.002, from 0.5 leading to 0.5 lagging.
 - d. Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.
 2. For meters that are circuit-breaker accessories, metering accuracy at full-scale shall not be less than the following:
 - a. Current: Plus or minus 2.5 percent.

- b. Voltage: Plus or minus 1.5 percent.
 - c. Energy, Demand, and Power: Plus or minus 4.0 percent.
 - d. Frequency: Plus or minus 1 Hz.
- P. Input: One digital input signal(s).
- 1. Normal mode for on/off signal.
 - 2. Demand interval synchronization pulse, accepting a demand synchronization pulse from a utility demand meter.
 - 3. Conditional energy signal to control conditional energy accumulation.
- Q. Outputs:
- 1. Operated either by user command sent via communication link, or set to operate in response to user-defined alarm or event.
 - 2. Closed in either a momentary or latched mode as defined by user.
 - 3. Each output relay used in a momentary contact mode shall have an independent timer that can be set by user.
 - 4. One digital KY pulse to a user-definable increment of energy measurement. Output ratings shall be up to 120-V ac, 300-V dc, 50 mA, and provide 3500-V rms isolation.
 - 5. One relay output module(s), providing a load voltage range from 20- to 240-V ac or from 20- to 30-V dc, supporting a load current of 2 A.
 - 6. Output Relay Control:
 - a. Relay outputs shall operate either by user command sent via communication link or in response to user-defined alarm or event.
 - b. Normally open and normally closed contacts, field configured to operate as follows:
 - 1) Normal contact closure where contacts change state for as long as signal exists.
 - 2) Latched mode when contacts change state on receipts of a pickup signal; changed state is held until a dropout signal is received.
 - 3) Timed mode when contacts change state on receipt of a pickup signal; changed state is held for a preprogrammed duration.
 - 4) End of power demand interval when relay operates as synchronization pulse for other devices.
 - 5) Energy Pulse Output: Relay pulses quantities used for absolute kWh, absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
 - 6) Output controlled by multiple alarms using Boolean-type logic.
- R. Onboard Data Logging:
- 1. Store logged data, alarms, events, and waveforms in 800 KB of onboard nonvolatile memory.
 - 2. Stored Data.
 - a. Billing Log: User configurable; data shall be recorded every 15 minutes, identified by month, day, and 15-minute interval. Accumulate 24 months of monthly data, 32 days of daily data, and between 2 and 52 days of 15-minute interval data, depending on number of quantities selected.
 - b. Custom Data Logs: Three user-defined log(s) holding up to 96 parameters. Date and time stamp each entry to the second and include the following user definitions:
 - 1) Schedule interval.
 - 2) Event definition.
 - 3) Configured as "fill-and-hold" or "circular, first-in first-out."
 - c. Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.
 - d. Waveform Log: Store captured waveforms configured as "fill-and-hold" or "circular, first-in first-out."
 - 3. Default values for all logs shall be initially set at factory, with logging to begin on device power up.
- S. Alarms.
- 1. User Options:
 - a. Define pickup, dropout, and delay.



- b. Assign two severity levels to make it easier for user to respond to the most important events first.
- 2. Alarm Events:
 - a. Over/undercurrent.
 - b. Over/undervoltage.
 - c. Current imbalance.
 - d. Phase loss, current.
 - e. Phase loss, voltage.
 - f. Voltage imbalance.
 - g. Over kW demand.
 - h. Phase reversal.
 - i. Digital input off/on.
 - j. End of incremental energy interval.
 - k. End of demand interval.
- T. Control Power: 90- to 457-V ac or 100- to 300-V dc.
- U. Communications:
 - 1. Power monitor shall be permanently connected to communicate via BACnet.
- V. Display Monitor:
 - 1. Backlighted LCD to display metered data with touch pad selecting device.
 - 2. Touch-screen display shall be a minimum 12-inch diagonal, resolution of 800 by 600 RGB pixels, 256 colors; NEMA 250, Type 1 display enclosure.
 - 3. Display 4 values on one screen at same time.
 - a. Current, per phase rms, three-phase average.
 - b. Voltage, phase to phase, phase to neutral, and three-phase averages of phase to phase and phase to neutral.
 - c. Real power, per phase and three-phase total.
 - d. Reactive power, per phase and three-phase total.
 - e. Apparent power, per phase and three-phase total.
 - f. Power factor, per phase and three-phase total.
 - g. Frequency.
 - h. Demand current, per phase and three-phase average.
 - i. Demand real power, three-phase total.
 - j. Demand apparent power, three-phase total.
 - k. Accumulated energy (MWh and MVARh).
 - l. THD, current and voltage, per phase.
 - 4. Reset: Allow reset of the following parameters at the display:
 - a. Peak demand current.
 - b. Peak demand power (kW) and peak demand apparent power (kVA).
 - c. Energy (MWh) and reactive energy (MVARh).

2.8 STANDALONE, WEB-ENABLED MONITORING INSTRUMENT

- A. Separately mounted, permanently installed instrument for power monitoring and control.
 - 1. Enclosure: NEMA Type 4x
- B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability.
 - 1. Indoor installation in non-air-conditioned spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
- C. Power-Distribution Equipment Monitor: Web enabled, with integral network port and embedded Web server with factory-configured firmware and HTML-formatted Web pages for viewing of power monitoring and equipment status information from connected devices equipped with digital communication ports.



- D. BACnet serial communication network, interconnecting all breaker trip units, protective relays, drives, and metering devices equipped with communications. Serial communication network connected to Ethernet server that functions as a gateway and server, providing data access via BACnet LAN.
- E. Communication Devices within the Equipment: Addressed at factory and tested to verify reliable communication with network server.
- F. Server Configuration:
 - 1. Initial network parameters set using a standard Web browser. Connect via a local operator interface, or an RJ-45 port accessible from front of equipment.
 - 2. Network server shall be factory programmed with embedded HTML-formatted Web pages that are user configurable and that provide detailed communication diagnostic information for serial and Ethernet ports as status of RS-485 network; with internal memory management information pages for viewing using a standard Web browser.
 - 3. Login: Password protected; password administration accessible from the LAN using a standard Web browser.
 - 4. Operating Software: Suitable for local access; firewall protected.
- G. Data Access:
 - 1. Network server shall include embedded HTML pages providing real-time information from devices connected to RS-485 network ports via a standard Web browser.
- H. Equipment Monitoring Options: Login shall be followed by a main menu for selecting summary Web pages that follow.
- I. Summary Web pages shall be factory configured to display the following information for each communicating device within the power equipment lineup:
 - 1. User-Configured Custom Home Page: Provide for the lineup, showing status-at-a-glance of key operating values.
 - 2. Circuit Summary Page: Circuit name, three-phase average rms current, power (kW), power factor, and breaker status.
 - 3. Load Current Summary Page: Circuit name, Phase A, B, and C rms current values.
 - 4. Demand Current Summary Page: Circuit name, Phase A, B, and C average demand current values.
 - 5. Power Summary Page: Circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
 - 6. Energy Summary Page: Circuit name, energy (kWh), reactive energy (kVARh), and time/date of last reset.
 - 7. Transformer Status Page: Transformer tag, coil temperatures, and cooling fan status.
 - 8. Motor-Control Center Status Page: Circuit name, three-phase average rms current, thermal capacity (percentage), and drive output frequency (Hz) contactor status.
 - 9. Specific Device Pages: Each individual communicating device shall display detailed, real-time information, as appropriate for device type.
 - a. Display historical energy data that shall be logged automatically for each device, as appropriate for device type.
 - b. Display historical data logged from each device in graphical time-trend plots. Value to be displayed on time-trend plot shall be user selectable. Time interval to be displayed on scale shall be for previous day or week.

2.9 LAN CABLES

- A. Cable:
 - 1. PVC-Jacketed, BACnet ms/tp Cable: Cat6a shielded.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CABLING

- A. Comply with NECA 1.
- B. Install cables and wiring.
- C. Wiring Method: Install wiring in raceway except within consoles, cabinets and counters. Conceal raceway and wiring except in unfinished spaces.
- D. Install LAN cables using techniques, practices, and methods that are consistent with specified category rating of components and that ensure specified category performance of completed and linked signal paths, end to end.
- E. Install cables without damaging conductors, shield, or jacket.

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."
- B. Label each power monitoring module with a unique designation.

3.4 GROUNDING

- A. Comply with IEEE 1100, "Recommended Practice for Powering and Grounding Electronic Equipment."

3.5 FIELD QUALITY CONTROL

- A. Prepare test and inspection reports.
- B. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.
- C. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
- D. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.
- E. Remove and replace malfunctioning devices and retest as specified above.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Campus maintenance personnel to adjust, operate, and maintain systems.
 - 1. Train Owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of 4 hours training.
 - 2. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

END OF SECTION 26 09 13

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Time switches.
 - 2. Photoelectric switches.
 - 3. Standalone daylight-harvesting switching controls.
 - 4. Indoor occupancy sensors.
 - 5. Outdoor motion sensors.
 - 6. Lighting contactors.
 - 7. Emergency shunt relays.
- B. Related Requirements:
 - 1. Section 26 27 26 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
 - 2. Include diagrams for power, signal, and control wiring. Differentiate between manufacturer installed and field installed wiring.
 - 3. Screenshot Mockup of diagram and controls over graphical floorplan.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans drawn to scale (1/4"=1'-0"), on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Location of occupancy sensors and relationships between adjacent architectural and structural components and adjacent structural, electrical, and mechanical elements. Layout shall be prepared by the sensor manufacturer.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

- A. All outdoor lights to be controlled by Nlights Control System Acuity brand with Eclypse Controller.
- B. "Nlight" Control System is a **Board of Trustees Approved Sole Source Item**. No substitutions will be accepted.
- C. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Contact Configuration: [SPST] [DPST] [DPDT] <Insert configuration>.
 - 3. Contact Rating: [30-A inductive or resistive, 240-V ac] [20-A ballast load, 120-/240-V ac]



4. Programs: Eight on-off set points on a 24-hour schedule[**and an annual holiday schedule that overrides the weekly operation on holidays**].
 5. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week [**and an annual holiday schedule that overrides the weekly operation on holidays**].
 6. Programs: each channel is individually programmable with eight on-off set points on a 24-hour schedule.
 7. Programs: each channel is individually programmable with two on-off set points on a 24-hour schedule with a skip-a-day weekly schedule.
 8. Programs: <Insert number> channels; each channel is individually programmable with two on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
 9. Programs: each channel is individually programmable with 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.
 10. Programs: each channel is individually programmable with 40 on-off operations per week, plus four seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.
 11. Programs: annual holiday schedule that overrides the weekly operation on holidays.
 12. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program [**on selected channels**].
 13. Astronomic Time: [**All**] [**Selected**] channels.
 14. Automatic daylight savings time changeover.
 15. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.
- D. Electromechanical-Dial Time Switches: Comply with UL 917.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Contact Configuration: [**SPST**] [**DPST**] [**SPDT**] [**DPDT**] <Insert configuration>.
 3. Contact Rating: [**30-A inductive or resistive, 240-V ac**] [**20-A ballast load, 120-/240-V ac**].
 4. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
 5. Astronomic time dial.
 6. Eight-Day Program: Uniquely programmable for each weekday and holidays.
 7. Skip-a-day mode.
 8. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of [**16**] hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following manufacturers**
1. Nlights Control System Acuity brand.
 2. "Nlight" Control System is a Board of Trustees Approved Sole Source Item. No substitutions will be accepted.
- B. Description: Solid state, with [**SPST**] [**DPST**] dry contacts rated for [**1800-VA tungsten or 1000-VA inductive**] , to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range[, **and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off**].
 3. Time Delay: Fifteen second minimum, to prevent false operation.
 4. Surge Protection: Metal-oxide varistor.
 5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

- C. Description: Solid state, with [SPST] [DPST] dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
 - 3. Time Delay: Thirty-second minimum, to prevent false operation.
 - 4. Lightning Arrester: Air-gap type.
 - 5. Mounting: Twist lock complying with NEMA C136.10, with base.

2.3 DAYLIGHT-HARVESTING SWITCHING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following manufacturers**
 - 1. Nlights Control System Acuity brand.
 - a. Model No. NCMPDT, NCMADCX, NPODM, NGWY2
 - b. “Nlight” Control System is a **Board of Trustees Approved Sole Source Item**. No substitutions will be accepted.
- B. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack [mounted on luminaire], to detect changes in indoor lighting levels that are perceived by the eye.
- C. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 - 3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor is powered by the power pack.
 - 4. Power Pack: Dry contacts rated for [20] A ballast load at 120- and 277-V ac, for [15] A tungsten at 120-V ac, and for [1] hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - 5. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
 - 6. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc, with an adjustment for turn-on and turn-off levels within that range.
 - 7. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc, with an adjustment for turn-on and turn-off levels within that range.
 - 8. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
 - 9. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
 - 10. Test Mode: User selectable, overriding programmed time delay to allow settings check.
 - 11. Control Load Status: User selectable to confirm that load wiring is correct.
 - 12. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following manufacturers:**
 - 1. Nlights Control System Acuity brand with Eclipse Controller.
- B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
 - 1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 - 2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.

- b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. Sensor is powered by controller unit.
 - 3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
 - 4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

2.5 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Nlights Control System Acuity brand.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
 - 1. UL Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 - 4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - 5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 - 7. Bypass Switch: Override the "on" function in case of sensor failure.
 - 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
 - 1. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..
 - 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
 - 3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot-high ceiling.
- D. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy .
 - 1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 - 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch-high ceiling.
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch-high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot-high ceiling in a corridor not wider than 14 feet.
- E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.6 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers
1. Nlights Control System Acuity brand.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application[, **and shall comply with California Title 24**].
 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
- C. Wall-Switch Sensor Tag WS1:
1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of **[900 sq. ft.] [2100 sq. ft.]**.
 2. Sensing Technology: **[PIR] [Dual technology - PIR and ultrasonic]**.
 3. Switch Type: **[SP.] [SP, dual circuit.] [SP, manual "on," automatic "off.]" [SP, field selectable automatic "on," or manual "on" automatic "off.]"**
 4. Voltage: **[Match the circuit voltage] [120 V] [277 V] [Dual voltage, 120 and 277 V]; [passive-infrared] [dual-technology]** type.
 5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
 8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
- D. Wall-Switch Sensor Tag WS2:
1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft..
 2. Sensing Technology: PIR.
 3. Switch Type: **[SP.] [SP, dual circuit.] [SP, manual "on," automatic "off.]" [SP, field selectable automatic "on," or manual "on" automatic "off.]"**
 4. Voltage: **[Match the circuit voltage] [120 V] [277 V] [Dual voltage, 120 and 277 V]; [passive-infrared] [dual-technology]** type.
 5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.

8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.7 HIGH-BAY OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following manufacturer**
 1. Nlights Control System Acuity brand.
- B. General Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
 3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
 4. Operating Ambient Conditions: 32 to 149 deg F.
 5. Mounting: Threaded pipe.
 6. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 7. Detector Technology: PIR.
 8. Power and dimming control from the lighting fixture ballast that has been modified to include the dimming capacitor and MyzerPORT option.
- C. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet.
- D. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.8 EXTREME-TEMPERATURE OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturer
 1. Nlights Control System Acuity brand.
- B. Description: Ceiling-mounted, solid-state, extreme-temperature occupancy sensors with a separate power pack.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended application in damp locations.
 2. Operation: Turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
 3. Operating Ambient Conditions: From minus 40 to plus 125 deg F.
 4. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 5. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 6. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind cover.
 7. Bypass Switch: Override the "on" function in case of sensor failure.
 8. Automatic Light-Level Sensor: Adjustable from 2 to 10 fc; keep lighting off when selected lighting level is present.
- C. Detector Technology: PIR. Ceiling mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1500 sq. ft. when mounted on a 96-inch-high ceiling.
3. Detection Coverage (High Bay): Detect occupancy within 25 feet when mounted on a 25-foot-high ceiling.

2.9 OUTDOOR MOTION SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Nlights Control System Acuity brand.
- B. General Requirements for Sensors: Solid-state outdoor motion sensors.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application[, **and shall comply with California Title 24**].
 2. **[PIR] [Dual-technology (PIR and infrared)]** type, weatherproof. Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.. Comply with UL 773A.
 3. Switch Rating:
 - a. Lighting-Fixture-Mounted Sensor: **[500-VA fluorescent]**
 - b. Separately Mounted Sensor: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 4. Switch Type: **[SP.] [SP, dual circuit.] [SP, manual "on," automatic "off. "] [SP, field selectable automatic "on," or manual "on" automatic "off. "] [With bypass switch to override the "on" function in case of sensor failure.]**
 5. Voltage: **[120-V] [277-V] [Dual voltage, 120- and 277-V]** type.
 6. Detector Coverage:
 - a. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft..
 - b. Long Range: 180-degree field of view and 110-foot detection range.
 7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 9. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
 10. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.
 11. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as "raintight" according to UL 773A.

2.10 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements provide products by one of the following manufacturers
1. Nlights Control System Acuity brand.
- B. Description: Electrically operated and **[mechanically] [electrically]** held, combination-type lighting contactors with **[fusible switch] [nonfused disconnect]**, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation. Verify faulty level with Short Circuit and Coordination Study for OCPDs.
 3. Enclosure: Comply with NEMA 250.
 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

- C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
 - 1. Monitoring: On-off status,
 - 2. Control: On-off operation

2.11 EMERGENCY SHUNT RELAY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers
 - 1. Nlights Control System Acuity brand.
- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual [or automatic switching contacts; complying with UL 924.
 - 1. Coil Rating: [120] [277] V.

2.12 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.
- C. Each N-light device shall be addressed in the programming with the corresponding Campus, bld # and Room #



3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Lighting control devices will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within [12] months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to [two] visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.7 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 26 09 43.13 "Addressable-Fixture Lighting Controls" and Section 26 09 43.23 "Relay-Based Lighting Controls."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Training shall be held on site after the system, devices are completely functional. Date and time shall be selected at the convenience of the owner's personnel.

END OF SECTION 26 09 23

**SECTION 26 09 33
CENTRAL DIMMING CONTROLS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes microprocessor-based central dimming controls with the following components:
 - 1. Digital control network.
 - 2. Master-control stations.
 - 3. Partitioned-space master-control stations.
 - 4. Wall stations.
 - 5. Dimmer cabinets.
 - 6. Manual switches and plates for controlling dimmers.
- B. Related sections:
 - 1. Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
 - 2. Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
 - 3. Section 26 05 53 "Identification for Electrical Systems"
 - 4. Section 26 27 26 "Wiring Devices"

1.3 DEFINITIONS

- A. Fade Override: The ability to temporarily set fade times to zero for all lighting scenes.
- B. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.
- C. Fade Time: The time it takes all zones to fade from one lighting scene to another, with all zones arriving at the next scene at the same time.
- D. Low Voltage: As defined in NFPA 70, term for circuits and equipment operating at less than 50 V or for remote-control, signaling, and power-limited circuits.
- E. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
- F. SCR: Silicon-controlled rectifier.
- G. Zone: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a "channel."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product submit manufacturers technical data and catalog cuts.
 - 1. For central dimming controls; include elevation, features, characteristics, and labels.
 - 2. For dimmer panels; include dimensions, features, dimmer characteristics, ratings, and directories.
 - 3. Device plates, plate color, and material.
 - 4. Ballasts and lamp combinations compatible with dimmer controls.
 - 5. Sound data including results of operational tests of central dimming controls.
 - 6. Operational documentation for software and firmware.
- B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
 - 1. Include elevation views of front panels of control and indicating devices and control stations.
 - 2. Include diagrams for power, signal, and control wiring. Differentiate between manufacturer installed and field installed wiring.
- C. Samples for Initial Selection: For master-control stations, partitioned-space master-control stations, wall stations, dimmer cabinets, and faceplates with factory-applied color finishes and technical features.



- D. Samples for Verification: For master-control stations, partitioned-space master-control stations, wall stations, dimmer cabinets, and faceplates with factory-applied color finishes and technical features.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For central dimming controls with remote-mounting dimmers to include in emergency, operation, and maintenance manuals.
 - 1. Include the following:
 - a. Software manuals.
 - b. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
 - c. Operation of adjustable zone controls.
 - d. Testing and adjusting of panic and emergency power features.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Dimmers: Full-size units equal to percent of amount installed for each size indicated, but no fewer than two units.
 - 2. Fuses: Equal to 10 percent of amount installed for each size and type installed, but no fewer than three.

1.8 QUALITY ASSURANCE

- A. American made products have been acceptable to the Owner. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the Owner and all tests shall be witnessed by Owner's personnel. Testing procedures and test results shall be satisfactory to the Owner. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one Owner's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- B. Contractor shall ensure that the manufacturer has a minimum of 10 years experience in the production of Central Dimming Systems similar to the type and size specified in this project. Provide a list of three projects completed within the last five years. Include name, telephone number and email address of facility engineer for each project.
- C. Manufacturer shall have ISO 9001 or 9002 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer confirming the availability.
- E. Central Dimming Systems shall be assembled at the manufacturer's own manufacturing facility using its own major devices (e.g., dimmers, circuit breakers, relays) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- F. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Major components (e.g., dimmer modules, controls, circuit breakers) shall be manufactured within six months of installation.
- G. Source Limitations: Obtain Central Dimming Systems, dimmers, overcurrent protective devices and accessories through one source from a single manufacturer through a local distributor unless otherwise indicated.
- H. Comply with NFPA 70.
- I. Comply with NEMA PB 1.



- J. Comply with UL.
- K. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- L. Product Options: Drawings indicate size, profiles, and dimensional requirements of Dimming System Equipment and are based on the specific system indicated.
- M. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100, and marked for intended location and application.
- N. Testing Agency Qualifications:
 - 1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of last ten (10) years and has permanent in-house testing engineers and technicians involved with testing of dimming systems, panelboards and OCPDs similar to those specified on this project. NETA membership shall be valid.
 - 2. Testing company shall be located within 50 miles radius of the project.
 - 3. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
 - 4. Field Testing technician and supervisor shall have minimum ten (10) years experience in field testing of dimming systems, lighting panel boards similar to the type and rating specified on this project.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace on site all components of central dimming controls that fail in materials or workmanship within specified warranty period. Warranty shall cover all labor and materials.
 - 1. Failures include, but are not limited to, the following:
 - a. Damage from transient voltage surges.
 - 2. Warranty Period: **two** years from date of Substantial Completion.
 - 3. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for **eight** years, that failed in service due to transient voltage surges.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following manufacturers:**
 - 1. Acuity Brands, Inc.; Nlights control with Ecnlyse Controller.
 - 2. **"Nlight"** Control System is a **Board of Trustees Approved Sole Source Item**. No substitutions will be accepted.

2.2 GENERAL SYSTEM REQUIREMENTS

- A. Compatibility:
 - 1. Dimming control components shall be compatible with lighting fixtures, ballasts, and transformers.
 - 2. Dimming control devices shall be compatible with lighting control system components specified in Section 26 09 43.13 "Addressable-Fixture Lighting Controls" and Section 26 09 43.23 "Relay-Based Lighting Controls," and in Section 26 09 23 "Lighting Control Devices."
- B. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state dimmers and control panels.
 - 1. Alternative Line-Voltage Surge Suppression: Comply with requirements in Section 26 43 13 "Surge Protection for Low-Voltage Electrical Power Circuits" for **[Category A] [Category B]** locations.
- C. Dimmers and Dimmer Modules: Comply with UL 508.
 - 1. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.



2. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.

2.3 SYSTEM DESCRIPTION

- A. Description: Microprocessor-based Eclipse Controller, solid-state controls consisting of control stations and a separately mounted dimmer cabinet.
 1. Operation: Change variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a **[push button]** **[slider]** is operated.
 2. System control shall include master station(s), wall stations, and dimmer panels.
 3. Each zone shall be configurable to control the following light sources:
 - a. Fluorescent lamps with **[electronic]** **[magnetic]** ballasts.
 - b. Line-voltage incandescent lamps.
 - c. Low-voltage incandescent lamps.
 - d. Cold cathode lamps.
 - e. Non-dimmed loads.
 - f. LED lamps.
 4. Control of each zone shall interface with controls for the following accessory functions:
 - a. Curtains and drapes.
 - b. Blackout curtains.
 - c. Projector screens.
 - d. Motorized partitions.
 - e. Manually positioned partitions.
 5. Memory: Retain preset scenes and fade settings through power failures for at least **[90]** days by retaining physical settings of controls or by an on-board, automatically recharged battery.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

2.4 CONTROL NETWORK

- A. Dimmers shall receive signals from control stations that are linked to dimmer cabinet with a common network data cable.
- B. Functions of network control stations shall be set up at master station that include the number and arrangement of scene presets, zones, and fade times at wall stations.
 1. Control Voltage: 24- or 10-V dc.
 2. Comply with ESTA E1.11/USITT DMX 512-A for data transmission.

2.5 MASTER-CONTROL STATIONS

- A. NLight nGWY2 system controller
- B. **“Nlight”** Control System is a **Board of Trustees Approved Sole Source Item**. No substitutions will be accepted.
- C. Functions and Features:
 1. Control adjustment of the lighting level for each scene of each zone, and adjustment of fade-time setting for each scene change from one preset scene to another. Controls shall use **[digital rocker switches with LCD graphic display of light level]**
 2. Master channel shall raise and lower lighting level of all zones.
 3. Fade rate for each scene shall be adjustable from zero to **[60]** seconds.
 4. Fade override control for each scene.
 5. Recall each preset scene and allow adjustment of zone controls associated with that scene.
 6. Lockout switch to prevent changes when set.
 7. On and off scene controls for non-dim channel contactors.
 8. Emergency-control push button to bypass all controls, turning all dimmers to full bright and turning on non-dim channel contactors.

9. Master on and off switch; off position enables housekeeping controls.
 10. Housekeeping controls to turn on selected lighting fixtures for housekeeping functions.
 11. Push buttons for accessory functions.
 12. Enable and disable wall stations.
 13. Communications link to other master stations.
 14. Provide for connecting a portable computer to program the master station.
 15. Rear-illuminate all scene-select buttons.
 16. Show lighting-level setting and fade-rate setting graphically using LEDs or backlighted bar-graph indicator.
- D. Mounting: Single, flush wall box with manufacturer's standard faceplate **with hinged transparent locking cover**.

2.6 PARTITIONED-SPACE MASTER-CONTROL STATION

- A. Functions and Features:
1. Automatically combine and separate lighting and accessory function controls as spaces are configured with movable partitions; with controls for adjustment of the lighting level for each scene of each dimmer, and adjustment of fade-rate setting for each scene change from one preset scene to another.
 2. Master controls shall accommodate partitioning the space into **[six]** adjacent rooms.
 3. Manual controls to set up **[six]** scenes for each room. Include wall stations in each room to control scenes.
 4. Master channel to raise and lower the lighting level of all zones using slider controls..
 5. Adjustable fade rate for each scene from zero to **[60]** seconds.
 6. Fade override control for each scene.
 7. On and off scene controls for non-dim channel contactors.
 8. Emergency-control push button to bypass all controls, turning all dimmers to full bright and turning on non-dim channel contactors.
 9. Master on and off switch; off position enables housekeeping controls.
 10. Housekeeping controls to turn on selected lighting fixtures for housekeeping functions.
 11. Push buttons for accessory functions.
 12. Provide for connecting a portable computer to program the master station.
 13. Rear-illuminate all scene-select buttons.
 14. Show lighting-level setting and fade-rate setting graphically using LEDs or backlighted bar-graph indicator.
- B. Custom Graphics. Include a graphical display of room configurations and the names for each. Indicate the current spaces configuration with LCD graphic or LED-illuminated indicators, and show which wall stations are active. Inactive wall stations shall be automatically deactivated.
- C. Mounting: Single, flush wall box with manufacturer's standard faceplate **with hinged transparent locking cover**.

2.7 WALL STATIONS

- A. Nlight model nPODM Wallpods.
- B. **"Nlight"** Control System is a **Board of Trustees Approved Sole Source Item**. No substitutions will be accepted.
- C. Functions and Features:
1. Wall stations shall function as a submaster to a master station, containing limited control of selected scenes of the master station.
 2. Controls to adjust the lighting level of each dimmer for each scene, and the fade time setting for each scene change from one preset scene to another.
 3. Numbered push buttons to select scenes.

4. Off switch to turn master station off. **Operating the off switch at any remote station shall automatically turn on selected housekeeping lighting.**
 5. On switch turns all scenes of master station to full bright.
 6. Push-button controls for accessory functions.
- D. Mounting: Flush, wall box with manufacturer's **standard faceplate.**
- E. Hand-Held Cordless Control: Scene-select and accessory function push buttons using **infrared or radio-frequency** transmission.

2.8 DIMMER CABINETS

- A. Factory wired **convection cooled without fans with barriers to accommodate 120- and 277-V feeders** and suitable to control designated lighting equipment or accessory functions.
- B. Ambient Conditions:
1. Temperature: **[60 to 95 deg F]** .
 2. Relative Humidity: **[10 to 90]** percent, noncondensing.
 3. Filtered air supply.
- C. Dimmer Cabinet Assembly: UL listed and labeled.
- D. Cabinet Type: Plug in, modular, and accepting dimmers of each specified type in any plug-in position.
1. Integrated Fault-Current Rating: Minimum **[10,000]** A RMS symmetrical. Verify maximum available fault current from the Short Circuit Study.
- E. Lighting Dimmers: Solid-state SCR dimmers.
1. Primary Protection: thermal-magnetic circuit breaker, also serving as the disconnecting means. Breaker shall be fully rated for the available fault current.
 2. Dimmer response to control signal shall follow the "Square Law Dimming Curve" specified in IESNA's "IESNA Lighting Handbook."
 3. Dimming Range: 0 to 100 percent, full output voltage not less than **[98]** percent of line voltage.
 4. Dimmed circuits shall be filtered to provide a minimum 350-mic.sec. current-rise time at a 90-degree conduction angle and 50 percent of rated dimmer capacity. Rate of current rise shall not exceed 30 mA/mic.sec., measured from 10 to 90 percent of load-current waveform.
 5. Protect controls of each dimmer with a fuse **and transient voltage surge suppression.**
- F. Non-dim modules shall include relays with contacts rated to switch 20-A tungsten-filament load at 120-V ac and 20-A electronic ballast load at 277-V ac.
- G. Accessory function control modules shall be compatible with requirement of the accessory being controlled.
- H. Digital Control Network:
1. Dimmers shall receive digital signals from digital network control stations that are linked to the dimmer cabinet with a common network data cable.
 2. Functions of digital network control stations shall be set up at the dimmer cabinet's electronic controls that include indicated number and arrangement of scene presets, channels, and fade times.
- I. Emergency Power Transfer Switch: Comply with UL 1008; factory prewired and pretested to automatically transfer load circuits from normal to emergency power supply when normal supply fails.
1. Transfer from normal to emergency supply when normal-supply voltage drops to 55 percent or less.
 2. Retransfer immediately to normal on failure of emergency supply and after a field adjustable time-delay of 10 to 90 seconds on restoration of normal supply while emergency supply is available.
 3. Integrated Fault-Current Rating: Same value as listed for the panel.
 4. Test Switch: Simulate failure of normal supply to test controls associated with transfer scheme.
 5. Fabricate and test dimmer boards to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

2.9 PORTABLE COMPUTER



- A. Description: As recommended by master-control-station manufacturer, to program master station and associated wall stations[, **and all interconnected master stations**]. Portable computer shall be laptop style with a battery runtime of at least two hours. Display shall be an 11-inch interactive-matrix LCD and shall have required hardware, firmware, and software to program specified control functions of master-control stations. Include required upgrades needed in next five (5) years at no additional cost.
- B. Software shall be configured and customized by master-station manufacturer. Provide unconditional Software license in owner's name.

2.10 MANUAL SWITCHES AND PLATES

- A. Switches: Modular, momentary push-button, low-voltage type.
 - 1. Color: White unless otherwise indicated; red when associated with emergency circuits.
 - 2. Integral Pilot Light: Indicate when circuit is on. Use where indicated.
 - 3. Locator Light: Internal illumination.
 - 4. Wall Plates: Comply with requirements in Section 262726 "Wiring Devices" for materials, finish, and color. Use multigang plates if more than one switch is indicated at a location.
 - 5. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.11 CONDUCTORS AND CABLES

- A. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than **[No. 18]** AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than **[No. 14]** AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- D. Unshielded, Twisted-Pair Data Cable: **[Category 5e]** **[Category 6]**. Comply with requirements in Section 27 15 00 "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method:
 - 1. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
 - 2. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 27 15 00 "Communications Horizontal Cabling."
 - 3. Minimum conduit size shall be 1/2 inch.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- F. Install dimmer cabinets for each zone.

3.2 IDENTIFICATION

- A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems" for identifying components and power and control wiring.
- B. Label each dimmer module with a unique designation.



- C. Label each scene control button with approved scene description.
- D. **Label each gateway, bridge, switch, sensor, with room number, lighting controller number and location, panel number and circuit number.**
- E. Coordinate labeling scheme with owner prior to making labels.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: **[Engage]** a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Continuity tests of circuits.
 - 2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
 - a. Include testing of dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
 - 3. Emergency Power Transfer: Test listed functions.
- D. Remove and replace malfunctioning dimming control components with new original components and retest as specified above.
- E. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
- F. Reports: Submit written reports of tests and observations within two weeks of completion of tests. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.4 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, service agreement shall include software support for **[two]** years.
- B. Upgrade Service: At Substantial Completion, update software to latest version at no additional cost. Install and program software upgrades that become available within **[two]** **<Insert number>** years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least **[30]** days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.5 DEMONSTRATION

- A. **Engage a factory-authorized service representative to train** Owner's maintenance personnel to adjust, operate, and maintain central dimming controls. **Laptop portable computer shall be used in training.** Training shall be held on site after the system is complete and functional. Time and date shall be at the convenience of the owner. Provide minimum two (2) weeks advance notice.
- B. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Section 26 09 43.13 "Addressable-Fixture Lighting Controls" and Section 26 09 43.23 "Relay-Based Lighting Controls."

END OF SECTION 26 09 33

**SECTION 26 11 16
SECONDARY UNIT SUBSTATIONS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes indoor and outdoor secondary unit substations, each consisting of the following:
 - 1. Primary incoming section.
 - 2. Transformer.
 - 3. Secondary distribution section.
- B. Unit substation shall be front aligned
- C. Related Sections include the following:
 - 1. 26 05 13 "Medium-Voltage Cables" for requirements of terminating cables in incoming section of substation.
 - 2. Section 26 05 26 "Grounding and Bonding For Electrical Systems".
 - 3. Section 26 05 48 "Vibration and Seismic Controls For Electrical Systems"
 - 4. Section 26 05 73 "Overcurrent Protective Device Coordination Study" for short-circuit rating of devices and for setting of overcurrent protective devices.
 - 5. Section 26 09 13 "Electrical Power Monitoring and Control" for communication features of power distribution system devices.
 - 6. Section 26 13 00 "Medium-Voltage Switchgear" for metering and instrument transformers.
 - 7. Section 26 25 00 "Enclosed Bus Assemblies" for busway connections between transformers and secondary distribution equipment.
 - 8. Section 26 36 00 "Transfer Switches" for transfer switches that may be located in secondary distribution section.
 - 9. Section 26 43 13 "Surge Protection for Low-Voltage Electrical Power Circuits" for transient voltage surge suppressors for low-voltage power, control, and communication equipment that may be located in secondary section.

1.3 DEFINITIONS

- A. AFF: Above finished floor.
- B. NETA ATS: InterNational Electrical Testing Association - Acceptance Testing Specification.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Substations shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

- A. Product Data: Manufacturer's technical data sheets and catalog cuts for primary switch, transformer, secondary main circuit breaker, secondary distribution board, feeder over current protective devices, instrumentation, surge protection, heaters, controls and other components including rated capacities, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Shop drawings shall be prepared by the factory engineer.

1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer installed and field installed wiring.
 2. Dimensioned plans and elevations to scale (1/4"=1'-0") showing major components and features.
 3. One-line diagram.
 4. List of materials.
 5. Nameplate legends.
 6. Size and number of bus bars and current rating for each bus, including mains and branches of phase, neutral, and ground buses.
 7. Short-time and short-circuit current ratings of secondary unit substations and components.
 8. Ratings of individual protective devices.
- C. Time-Current Characteristic Curves: For overcurrent protective devices.
- D. Primary Fuses: Submit manufacturer's recommendations and size calculations. Size of fuse shall be verified by the over current protective device coordination study prior to shipment of fuse from the factory.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Ceiling and floor plans, drawn to scale (1/4"=1'-0"), on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Show structural members e.g columns, beams, doors etc. within the area where substation is located.
 2. Show containment curb for containment of liquid (per applicable regulations) for substations with liquid type transformers.
 3. Dimensioned concrete base, outline of secondary unit substation, conduit entries, and ground rod locations.
 4. Location of structural supports for structure-supported raceways, busways, and seismic bracing.
 5. Location of lighting fixtures, sprinkler piping and heads, ducts, and diffusers.
 6. Layout of substation in room, area, or yard to scale including horizontal and vertical clearances around the substation.
- B. Qualification Data: For testing agency.
- C. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems." Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For secondary unit substations, signed by product manufacturer certifying that products furnished comply with the specified requirements.
- E. Material Test Reports: For secondary unit substations, signed by the manufacturer certifying that the materials furnished comply with specified requirements.
- F. Factory test reports signed by manufacturer's testing engineer. Include name of the testing engineer, location and date of test. Submit minimum two (2) weeks prior to shipment of each substation to the site.
- G. Field quality-control test reports. Submit within two (2) weeks of completion of field tests.
- H. Manufacturer's installation instructions.



1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For secondary unit substations and accessories to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spare fuses: Six of each type and rating of fuse and fusible device used, except one set for each type of medium-voltage fuses Include spares for the following:
 - a. Primary disconnect fuses.
 - b. Potential transformer fuses.
 - c. Control power fuses.
 - d. Fuses and fusible devices for fused circuit breakers.
 - e. Fuses for secondary fusible devices.
 - 2. Spare Indicating Lights: Six of each type installed.
 - 3. Touchup Paint: Three half-pint containers of paint matching enclosure's exterior finish.
 - 4. Primary Switch Contact Lubricant: One container.
 - 5. One set of spare mounting gaskets for bushings, handholes, and the gasket between relief cover and flange of pressure relief device.

1.9 QUALITY ASSURANCE

- A. American made products have been acceptable to the Owner. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the Owner and all tests shall be witnessed by Owner's personnel. All testing procedures and test results shall be satisfactory to the Owner. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one Owner's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- B. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of Secondary Unit Substations similar to the type and size specified in this project. Furnish a list of minimum three (3) installations with similar equipment completed within the last five (5) years. Include name and telephone number of the facility engineer for each installation.
- C. Manufacturer shall have ISO 9001 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project
- E. Substation shall be assembled at the manufacturer's own manufacturing facility using its own major devices (e.g., primary switch, circuit breakers) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- F. Unit substation shall comply with seismic zone applicable to the project. Unless otherwise indicated, verify requirements with Architect or Structural Engineer of Record (SEOR). Provide certified test reports of shake table test done by manufacturer of substation on similar units.
- G. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Major components (e.g., primary switch, transformer, and switchboard) shall be manufactured within six months of installation.
- H. Source Limitations: Obtain secondary unit substation through one source from a single manufacturer through a local distributor. All power distribution equipment shall be of the same manufacturer as the substation.
- I. Comply with IEEE C2.
- J. Comply with IEEE C37.121.
- K. Comply with NFPA 70.



- L. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- M. Product Options: Drawings indicate size, profiles, and dimensional requirements of secondary unit substations and are based on the specific system indicated
- N. Electrical Components, Devices, Accessories including complete assembly: UL Listed and labeled as defined in NFPA 70, Article 100, and marked for intended use.
- O. Testing Agency Qualifications:
 - 1. Testing agency shall be an independent company with the experience to conduct field testing as indicated; shall have been a member of Inter-National Testing Association (NETA) for a minimum of last ten (10) years.
 - 2. The company shall have permanent in-house testing engineers and technicians.
 - 3. Testing company shall be located with 50 miles radius of the project.
 - 4. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
 - 5. Field Testing technician and supervisor shall have minimum ten (10) years' experience in field testing of unit substations similar to the type and rating specified on this project.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
- B. Coordinate delivery of secondary unit substations to allow movement into designated space. Make sure the space is ready and clean for installation
- C. Store secondary unit substation components protected from dust and weather so that the condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions. Verify that the storage area is dust free.
- D. Handle secondary unit substation components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.11 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions by field measurements and indicate measurements on Shop Drawings.
- B. Interruption of Existing electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify College no fewer than fourteen (14) days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without College Representative's written permission.
 - 3. Comply with NFPA 70E.
 - 4. Provide temporary standby power through a standby diesel quiet type back-up generator complete with fuel and 7/24 monitoring if the existing service interruption exceeds 2 hours. Coordinate additional requirements with owner minimum fourteen days in advance. Indicate method of providing temporary electric service.
- C. Service Conditions: IEEE C37.121, usual service conditions, except for the following:
 - 1. Exposure to significant solar radiation.
 - 2. Altitudes above 3300 feet (1000 m).
 - 3. Exposure to fumes, vapors, or dust.
 - 4. Exposure to explosive environments.
 - 5. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
 - 6. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
 - 7. Exposure to excessively high or low temperatures.



8. Unusual transportation or storage conditions.
9. Unusual grounding resistance conditions.
10. Unusual space limitations.

1.12 COORDINATION

- A. Coordinate layout and installation of secondary unit substations with other construction that penetrates floors and ceilings, or is supported by them, including light fixtures, HVAC equipment, and fire-suppression-system components.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products (primary switch and secondary section) by one of the following:
 1. ABB Control, Inc.
 2. Cooper Industries, Inc.; Cooper Power Systems Division.
 3. Square D; Schneider Electric
 4. Eaton-Cutler-Hammer.
 5. GE Electrical Distribution & Control.
 6. Siemens Energy & Automation, Inc.
- C. Manufacturers: Subject to compliance with requirements, provide substation transformer by the following:
 1. ABB or equal, no known equal.

2.2 MANUFACTURED UNITS

- A. Indoor Unit Arrangement: Single assembly consisting of primary section, transformer and secondary distribution section bus connected.
- B. Indoor Unit Arrangement: Separate secondary distribution equipment connected with overhead busway.
- C. Outdoor Unit Arrangement: Single assembly
 1. Weatherproof, NEMA 4X stainless steel enclosure, listed for installation outdoors, complying with IEEE C37.20.1.
 2. Aisleless Construction: Full-height doors in front of basic weatherproof equipment.
- D. Enclosure Finish: Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.

2.3 INCOMING SECTION

- A. Primary Incoming Section: Enclosed, air-interrupter, [primary] switch.
 1. Floor standing, 15000V/5000V rating, 95kV Basic Impulse Level (BIL), air insulated, quick-make, quick-break, permanently attached manual operating handle (maximum height 5'6" AFF inclusive of housekeeping pad), silver plated copper bussing. Copper bus connection to transformer except that final connection shall be with copper braided flexible straps. Copper braided flexible straps shall be fully rated for full load rating of the switch.
 2. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, with fuses mounted on a single frame fuses complying with IEEE C37.20.3.
 3. Key interlocking system to prevent fuse access door from being opened unless switch is open. Additionally, interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.
 4. Phase Barriers: Located between blades and fuses of each phase, designed for easy removal, allows visual inspection of switch components when barrier is in place.



5. Shatter Resistant Viewing Window: Permits viewing switch-blade positions when front door is closed. Maximum height 5-6" Above finished floor inclusive of housekeeping pad.
6. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
7. Continuous-Current Rating: [600 A].
8. Short-Circuit Rating:
 - a. Short-time momentary asymmetrical fault rating of [40 kA];
 - b. 3-second symmetrical rating of [25kA] RMS.
 - c. Fault close asymmetrical rating of [40 kA.
9. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading. Comply with the following:
 - a. Current-limiting type, rated for not less than 50-kA RMS symmetrical current-interrupting capacity.
 - b. Indicator integral with each fuse to show when it has blown.
 - c. Spares: Include three fuses in use and three spare fuses in storage clips in each switch.
- B. NEMA class porcelain insulators for bus supports and porcelain inserts at bus penetrations between sections.
- C. Warning signs: Provide warning signs stating "Danger High Voltage – Keep Out" on front and rear of equipment. Sign shall comply with OSHA requirements.
- D. Surge Arresters: Comply with IEEE C62.11, Distribution class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of any disconnecting device.
- E. Bussing shall be rated to withstand maximum short circuit stresses when connected to a supply system having a fault capacity of 750MVA symmetrical at rated voltage.
- F. Provide copper bus connection between transformer and secondary distribution except that final 12 inches shall be copper braided straps.
- G. Provide strip heaters to prevent condensation and connect to a low voltage (120 or 208V) circuit from low voltage panel or from a control power transformer if local power source is not available.
- H. Indoor Enclosures: NEMA type 1 with rear hinged door. Provide with pad locking provision.
- I. Outdoor Enclosures: NEMA 4X stainless steel with sloping roof rearward and rear hinged door. Provide with pad locking provision.

2.4 LIQUID-FILLED TRANSFORMER SECTION

- A. Description: IEEE C57.12.00 and UL 1062, liquid-filled, 2-winding, secondary unit substation transformer.
- B. Windings shall be copper.
- C. Insulating Liquid: Less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
- D. Insulating Liquid: Less flammable, dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
- E. Insulating Liquid: Less flammable, silicone-based dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall have low toxicity and be nonhazardous.
- F. Insulation Temperature Rise: 65/55 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C. Insulation system shall be rated to continuously allow an additional 12-percent kVA output, at 65 deg C temperature rise, without decreasing rated transformer life.
- G. Basic Impulse Level: Comply with UL 1062.



- H. Basic Impulse Level: [95] kV.
- I. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps, 2 above and 2 below rated primary voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
- J. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps below rated primary voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
- K. Cooling System: Class OA, liquid cooled Cooling systems shall include auxiliary cooling equipment, automatic controls, and status indicating lights.
- L. Sound level shall may not exceed 58 dB, without fans or ANSI standard..
- M. Impedance: 5.75 percent or ANSI standard.
- N. Accessories: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers shall have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap. Include the following additional accessories:
 - 1. Liquid-level gage.
 - 2. Pressure-vacuum gage.
 - 3. Liquid temperature indicator.
 - 4. Drain and filter valves.
 - 5. Pressure relief device.

2.5 DRY-TYPE TRANSFORMER SECTION

- A. Description: IEEE C57.12.01, [IEEE C57.12.50] [IEEE C57.12.51] [IEEE C57.12.52], NEMA ST 20, and dry-type, 2-winding, secondary unit substation transformer.
- B. Windings shall be copper.
- C. Enclosure: [Indoor, ventilated], cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 220 deg C with an 115 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
- D. Enclosure: [Indoor, ventilated] vacuum-pressure, impregnated type and with insulation system rated at 220 deg C with an 115 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
- E. Cooling System: Class [AA/FFA, air cooled with provisions for future forced-air rating], complying with IEEE C57.12.01.
 - 1. Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm silencing relay.
 - 2. Include mounting provision for fans.
- F. Insulation Materials: IEEE C57.12.01, rated 220 deg C.
- G. Insulation Temperature Rise: 115 deg C, maximum rise above 40 deg C.
- H. Basic Impulse Level: [95] kV.
- I. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps, 2 above and 2 below rated primary voltage with externally operable tap changer for de-energized use and with position indicator and padlock hasp..
- J. Sound level may not exceed maximum 58 dBA level, without fans operating.
- K. Impedance: 5.75 percent or ANSI standard..
- L. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.
- M. Provide copper bus connection between transformer and secondary distribution except that final 12 inches shall be copper braided straps.
- N. Porcelain barriers between sections and porcelain insulators for high voltage buss shall be provided.



- O. Ground bus shall be 1/4 x 2 inch copper with appropriate terminal connection locations and shall extend the full length of the enclosure.

2.6 SECONDARY DISTRIBUTION SECTION

- A. Secondary Terminal Compartment: Bus bars mounted on standoff porcelain insulators
- B. Secondary Distribution: Low-voltage switchgear as specified in Section 262300 "Low-Voltage Switchgear."
- C. Secondary Distribution: Low-voltage switchboard as specified in Section 262413 "Switchboards."
- D. Secondary Distribution: Motor-control center as specified in Section 262419 "Motor-Control Centers."
- E. Distribution Panelboard: Panelboards as specified in Section 262416 "Panelboards."
- F. Minimum 65,000 amperes interrupting capacity (RMS Symmetrical) unless otherwise noted. Rated voltage per single line diagram.
- G. Enclosure: NEMA 1 for indoor and NEMA 4X Stainless steel walk-in type for outdoor substations.
- H. Zero sequence type ground fault protectors shall be provided. Relay, field adjustable with solid-state circuitry to shunt trip breakers. Monitor panel on face of switchboard with READY pilot light, ground fault indicator, reset button, provisions for field for field test without service interruption and alarm contact.
- I. Copper ground bus extends for full length of switchboard mounted and bonded to each section with provision for feeder ground terminations. Fully rated, non-tapered neutral bus. Completely factory wired and assembled.
- J. Meters: Provide digital electronic meters if service is from Owner's power distribution system. Match new meters with Owner's existing standard if required by Owner. Verify.
- K. Network Protectors:
 - 1. Rated for continuous service in an ambient temperature of up to 40 deg C, applied to 3-phase, 4-wire, solidly grounded wye secondary networks. Comply with IEEE C57.12.44.
 - 2. Dead-front, drawout design with externally mounted fuses, using hand-cranked rail system. Relay and control panel located on a separate drawout module.
 - 3. Protector Operator: **[Spring-close] [and] [or] [stored-energy]** mechanism, rated to close on a **[25,000] [40,000]** RMS symmetrical load.
 - 4. Control Voltage: Not more than 125 V.
 - 5. Control microprocessor-based, three-phase, tripping relay with features and functions as follows:
 - a. Close protector if positive sequence power flows into the network. Adjustable closing range shall be from 0.5 to 3.5 V in phase difference between network and transformer voltages.
 - b. Trip protector if there is a net, three-phase, reverse power flow through protector. Trip protectors shall be adjustable from 0.05 to 5 percent of continuous-current rating of current transformers within protector.
 - c. Trip protector if there is a flow of reverse magnetizing current of its associated transformer.
 - d. Field-adjustable relay parameters and watt or watt-var trip values.
 - 6. Protector shall not open under any fault on network side of protector.
 - 7. Current-limiting fuses shall have interrupting capacity of 150,000 A on network side of protector for protection against switchboard bus faults.
 - 8. Mechanical interlocks shall prevent racking in and racking out when protector is closed.
 - 9. Auxiliary contacts shall be remotely tripped and locked out by four-wire remote pilot devices.
 - 10. Network protectors shall have not less than two spare auxiliary dry contacts.
 - 11. Network Switchgear-Mounted Disconnect Switch: Supply each network-protector circuit with a switchgear-mounted fuse truck, with Class L fuses rated for 200-kA interrupting capacity, and key interlocked with each associated protector.
 - 12. Network Switchgear-Mounted Disconnect Switch: Supply each network-protector circuit with a switchgear-mounted main circuit breaker rated for fault current that can be delivered by the network transformers, less one. Use drawout type to provide a means of isolating the load side of each protector from the network bus.



2.7 IDENTIFICATION DEVICES

- A. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.8 SOURCE QUALITY CONTROL

- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear and switchboard tests according to ANSI C37.51.
- B. Factory Tests: Perform the following factory-certified tests on each secondary unit substation:
 - 1. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
 - 2. Ratios on the rated voltage connection and on tap extreme connections.
 - 3. Polarity and phase relation on the rated voltage connection.
 - 4. No-load loss at rated voltage on the rated voltage connection.
 - 5. Exciting current at rated voltage on the rated voltage connection.
 - 6. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
 - 7. Applied potential.
 - 8. Induced potential.
 - 9. Temperature Test: If a transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class FA rating.
 - a. Temperature test is not required if a record of a temperature test on an essentially duplicate unit is available.
 - 10. Owner or owner's representative will witness all required factory tests. Notify Architect at least 30 days before date of tests and indicate their approximate duration.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of work.
- B. Examine roughing-in of conduits and grounding systems to verify the following:
 - 1. Wiring entries comply with layout requirements.
 - 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.
- D. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at secondary unit substation location.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install secondary unit substations on concrete bases.
 - 1. Anchor secondary unit substations to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" and Section 260548 "Vibration and Seismic Controls for Electrical Systems."
 - 2. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and 4 inches (100 mm) high.

3. Use [3000-psi (20.7-MPa)] , 28-day compressive-strength concrete and reinforcement as specified in [Section 03 30 00 "Cast-in-Place Concrete."] [Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."]
 4. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
 5. Install epoxy-coated anchor bolts for anchoring equipment to the concrete base.
 6. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 7. Bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- C. Maximum height of Over Current Protective Devices shall be 6'-6" above finished floor to the center of the grip of the device operating handle in its highest position. unless otherwise indicated or a lower height is required by code.

3.3 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs as specified in Section 260553 "Identification for Electrical Systems."
- B. Operating Instructions: Frame printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of secondary unit substation.

3.4 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.5 CLEANING

- A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Testing: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- C. Perform the following field tests and inspections and prepare test reports:
1. Perform each visual and mechanical inspection and electrical test according to NETA ATS. Certify compliance with test parameters.
 2. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation tested at the specified value or less.
 3. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
 4. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
 - a. Remove and replace malfunctioning units and retest as specified above.

3.7 FOLLOW-UP SERVICE

- A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:



1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
 2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
 - a. Adjust transformer taps.
 - b. Rebalance loads.
 - c. Prepare written request for voltage adjustment by electric utility.
 3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
 4. Report: Prepare a written report covering monitoring performed and corrective action taken.
- B. Infrared Scanning: Perform as specified in Section 26 13 00 "Medium-Voltage Switchgear."

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems.

END OF SECTION 26 11 16

SECTION 26 12 00
MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of transformers with medium-voltage primaries:
 - 1. Dry-type distribution and power transformers.
 - 2. Pad-mounted, liquid-filled transformers.
 - 3. **Cast Coil Transformers**

1.3 DEFINITIONS

- A. NETA ATS: Acceptance Testing Specification.

1.4 ACTION SUBMITTALS

- A. Product Data: Manufacturer's technical data indicating rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices, fuses and features, location of each field connection, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Diagram for power, signal and control wiring.
- C. Type and size of fuses shall be verified by the coordination study.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale (1/4"=1'-0") on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Underground primary and secondary conduit stub-up location.
 - 2. Dimensioned concrete base, outline of transformer, and required clearances.
 - 3. Ground rod and grounding cable locations.
- B. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Qualification Data: For testing agency.
- D. Source quality-control test reports. Certified written reports signed by factory testing engineer or technician including their name and review comments from the testing engineer. Each report shall include date, location of tests and actual test data. Submit factory tests prior to shipment of the unit.
- E. Field quality-control test reports. Submit within two (2) weeks of completion of field tests.
- F. Follow-up service reports.



1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. American made products have been acceptable to the College. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the College and all tests shall be witnessed by College personnel. All testing procedures and test results shall be satisfactory to the Owner. The Contractor shall bear all costs for testing and shall be responsible for all costs associated with travel, lodging, etc. for (1) College Representative to witness the test at the manufacturer's testing facility. The Contractor shall reimburse the Owner at \$1,200 per man day or part thereof for the time required to witness the testing. Include all costs for the above in the bid.
- B. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of medium voltage transformers similar to the type and size specified in this project.
- C. Manufacturer shall have ISO 9001 and 9002 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten years, from the date of completion of the project. Provide a letter from the manufacturer confirming the above statement.
- E. Transformer shall be manufactured within 12 months of installation and shall be provided with a 3 year warranty.
- F. Electrical Components, Devices, Accessories including complete assembly: UL Listed and labeled as defined in NFPA 70, Article 100.
- G. Transformer shall comply with:
 - 1. Institute of Electrical and Electronic Engineers, IEEE C2, IEEE C57.12.10, IEEE C57.12.70, and IEEE C57.12.80.
 - 2. American National Standard Institute, ANSI C57.12.28.
 - 3. National Fire Protection Association (NFPA).
 - 4. State of California Code of Regulations (CCR).
- H. Testing Agency Qualifications:
 - 1. Testing agency shall be an independent company with the experience and capability to conduct field testing indicated; shall have been a member of International Testing Association (NETA) for a minimum of last ten (10) years.
 - 2. The company shall have permanent in-house testing engineers and technicians on its staff
 - 3. Testing company shall be located with 50 miles radius of the project.
 - 4. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
 - 5. Filed testing technician and supervisor shall have minimum ten (10) years experience in field testing of medium voltage transformers similar to the type and rating specified on this project.
- I. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store transformers protected from weather and dust so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.9 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

- B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D; Schneider Electric
 - 2. Eaton-Cutler-Hammer.
 - 3. GE Electrical Distribution & Control.
 - 4. Siemens Energy & Automation, Inc.

2.2 DRY-TYPE DISTRIBUTION AND POWER TRANSFORMERS

- A. Description: NEMA ST 20, IEEE C57.12.01, ANSI C57.12.50, ANSI C57.12.51, ANSI C57.12.52, UL 1562 listed and labeled, dry-type, 2-winding copper transformers.
 - 1. Indoor, ventilated, vacuum-pressure impregnated and with insulation system rated at 220 deg C with an 150 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
 - 2. **Indoor, ventilated, cast coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 220 deg C with an 150 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.**
- B. Primary Connection: Air terminal compartment with hinged door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.
- C. Primary Connection: Transition terminal compartment with connection pattern to match switchgear.
- D. Secondary Connection: Air terminal compartment with hinged door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.
- E. Secondary Connection: Transition terminal compartment with connection pattern to match switchgear.
- F. Insulation Materials: IEEE C57.12.01, rated at 220 deg C.
- G. Insulation Temperature Rise: 150 deg C, maximum rise above 40 deg C.
- H. Basic Impulse Level: 95 kV.
- I. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.
- J. Cooling System: Class OA, self-cooled. Cooling systems shall include auxiliary cooling equipment, automatic controls, and status indicating lights.
- K. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.
- L. Impedance: 5.75 percent.
- M. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

2.3 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

- A. Description: ANSI C57.12.13, IEEE C57.12.00, IEEE C57.12.22, pad-mounted, 2- copper winding transformers. Stainless-steel tank base and cabinet.
- B. Insulating Liquid: Less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
- C. Insulation Temperature Rise: 65 deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.



- D. Basic Impulse Level: 95 kV.
- E. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
- F. High-Voltage Switch: 200A or 400A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for radial feed with 3-phase, 2-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.
- G. Primary Fuses: 5-kV fuse assembly with fuses complying with IEEE C37.47. Rating of current-limiting fuses shall be 50-kA RMS at specified system voltage.
 - 1. Bay-O-Net liquid-immersed fuses in series with liquid-immersed current-limiting fuses. Bay-O-Net fuses shall be externally replaceable without opening transformer tank.
- H. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; support from tank wall within high-voltage compartment. Transformers shall have three arresters for radial-feed circuits.
- I. High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:
 - 1. Bushing-Well Feed Thru Inserts: One for each high-voltage bushing well.
 - 2. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units. Provide feed-thru inserts for each arrester.
 - 3. Parking Stands: One for each high-voltage bushing well.
- J. Low Voltage Terminations and Equipment: Molded epoxy, with blade type spade terminals with NEMA standard hole spacing arranged for vertical take off. Low-voltage neutral shall be an insulated bushing, grounded to tank by a removable ground strap. Location as shown on Drawings. Size of phase and neutral terminations shall be based on the load side conductors shown on the drawings.
 - 1. Drain Valve: 1 inch (25 mm), with sampling device.
 - 2. Dial-type thermometer.
 - 3. Liquid-level gage.
 - 4. Pressure-vacuum gage.
 - 5. Pressure Relief Device: Self-sealing with an indicator.
 - 6. Busway terminal connection at low-voltage compartment.
 - 7. Alarm contacts for gages and thermometer listed above.
- K. Enclosure: Enclosure shall be made of stainless steel with front accessible double doors padlockable. It shall have separate compartments for high voltage and low voltage terminations. Enclosure exterior finish shall be factory applied powder coated standard munsel green finish over a rust inhibiting primer on treated metal surface. Furnish a minimum of three (3) years warranty against corrosion.

2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems." Provide a separate name plate on the inside door indicating fuse size and type.

2.5 SOURCE QUALITY CONTROL

- A. Factory Tests: Perform routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90, IEEE C57.12.91.
- B. Factory Tests: Perform the following factory-certified tests on each transformer:
 - 1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
 - 2. Ratios on rated-voltage connection and on tap extreme connections.
 - 3. Polarity and phase relation on rated-voltage connection.
 - 4. No-load loss at rated voltage on rated-voltage connection.
 - 5. Excitation current at rated voltage on rated-voltage connection.

6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
7. Applied potential.
8. Induced potential.
9. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class OA/FA or Class AA/FA rating.
 - a. Temperature test is not required if record of temperature test on an essentially duplicate unit is available.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.
- B. Examine roughing-in of conduits and grounding systems to verify the following:
 1. Wiring entries comply with layout requirements.
 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and that requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install transformers on concrete bases.
 1. Anchor transformers to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems."
 2. Install exterior pad mount transformer on an underground handhole with concrete pad on top. Handhole shall be open bottom and have concrete barrier separating primary and secondary incoming cable sections. Refer to the mounting detail shown on the drawings. Provide rocks or gravel 1" size at the bottom.
 3. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and 4 inches (100 mm) high.
 4. Use 3000-psi (20.7-MPa) 28-day compressive-strength concrete and reinforcement as specified on the structural drawings.
 5. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
 6. Install epoxy-coated anchor bolts, for supported equipment, that extend through concrete base and anchor into structural concrete floor.
 7. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs as specified in Section 260553 "Identification for Electrical Systems."

3.4 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.
- B. Testing Agency: Engage an independent qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports. Refer to section 26 00 80 for additional information on testing.
- C. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
 - 2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Test Reports: Prepare written reports to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

3.6 FOLLOW-UP SERVICE

- A. Voltage Monitoring and Adjusting: If requested by Owner, perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:
 - 1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
 - 2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:
 - a. Adjust transformer taps.
 - b. Prepare written request for voltage adjustment by electric utility.
 - 3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.
 - 4. Report: Prepare written report covering monitoring and corrective actions performed.
- B. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of terminations in each transformer.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of terminations in each transformer 11 months after date of Substantial Completion.



2. Instrument: Use an infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies transformer checked and that describes infrared-scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action."

END OF SECTION 26 12 00

SECTION 26 13 00
MEDIUM VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section covers the general requirements for an integrated NEMA 1 indoor arc resistant metal-clad, circuit-breaker switchgear for distribution with the following optional components, features, and accessories:
 - 1. Copper, silver-plated main bus at connection points.
 - 2. Communication modules.
 - 3. Analog instruments.
 - 4. Digital Relays and power meters for energy monitoring with fast acting contacts and maintenance push button for arc flash mitigation.
 - 5. Surge arresters.
 - 6. Provisions for future devices.
 - 7. Control battery system.
 - 8. Mimic bus.
 - 9. Optical arc flash detection system.
- B. Metal-clad switchgear shall be provided with the Arc Flash Protection System or equal.

1.3 REFERENCES

- A. The metal-clad switchgear and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of IEEE, ANSI and NEMA.
- B. Applicable Codes and Standards
 - 1. The applicable codes and standards listed below should be considered as part of this specification. The latest revision in effect at time of inquiry shall apply for all standards referenced.
 - a. ANSI/IEEE C37.04 - Standard Rating Structure for AC HV Circuit Breakers
 - b. ANSI/IEEE C37.06 - Preferred Ratings for AC HV Circuit Breakers
 - c. ANSI/IEEE C37.09 - Standard Test Procedure for AC HV Circuit Breakers
 - d. ANSI/IEEE C37.010 - Application Guide for AC HV Circuit Breakers
 - e. ANSI/IEEE C37.011 - Application Guide for TRV for AC HV Circuit Breakers
 - f. ANSI/IEEE C37.012 - Application Guide for Capacitance Switching
 - g. ANSI/IEEE C37.11 - Requirements for Electrical Control.
 - h. ANSI/IEEE C37.20.7 - IEEE Guide for Testing Metal-Enclosed Switchgear Rated Up to 38kV for Internal Arcing Faults
 - i. ANSI/IEEE C37.20.2 - Standard for Metal-Clad and Station Type Cubicle Switchgear
 - j. ANSI/IEEE C37.55 - Conformance Testing Procedure of Metal-Clad Switchgear
 - k. ANSI/IEEE C57.13 - Requirements for Instrument Transformers
 - l. NFPA 70E - NEC Code 2009 Edition
 - m. CSA C22.2 - Switchgear Assemblies
 - n. NEMA CC1 - Electrical Power Connectors
 - o. NEMA SG-4 - Standards for Power Circuit Breakers
 - p. NEMA SG-5 - Power Switchgear Assemblies NEC/NFPA
 - q. NEMA 250 - Enclosures for Electrical Equipment
 - r. PIP ELESSG02 - Medium Voltage Metal-Clad Switchgear

1.4 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.



- B. GFCI: Ground-Fault Circuit Interrupter.

1.5 SUBMITTALS

- A. Product Data: For each type of switchgear and related equipment, include the following:
 - 1. Rated capacities, operating characteristics, furnished specialties, and accessories for individual circuit breakers.
 - 2. Time-current characteristic curves for overcurrent protective devices, including circuit-breaker relay trip.
- B. Shop Drawings: For each type of switchgear and related equipment, include the following:
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:
 - a. Tabulation of installed devices with features and ratings.
 - b. Bill of materials.
 - c. Bus Structure Diagram: For each equipment, provide bus structure diagram. Provide single line diagram using standard ANSI symbols.
 - d. Incoming voltage characteristics.
 - e. Indicate horizontal and vertical bus capacity in amperes and bar sizes.
 - f. Indicate ampere interrupting capacity (AIC) for all circuit breakers.
 - g. Indicate each bolted and stub-in provision for devices.
 - h. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
 - i. Drawing of cable termination compartments showing preferred locations for conduits and indicating space available for cable terminations.
 - j. Floor plan drawing showing locations for anchor bolts.
 - k. Current ratings of buses.
 - l. Short-time and short-circuit ratings of switchgear assembly.
 - m. Nameplate legends.
 - n. Mimic-bus diagram.
 - 2. Physical Data and Dimensions:
 - a. Front view elevation.
 - b. Floor plan.
 - c. Top view.
 - d. Conduit entry/exit locations.
 - 3. Catalog Cuts: Manufacturer's catalog cuts for each equipment, device, component including meters, CTs, Pts, switches etc.
 - 4. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting seismic restraints.
 - 5. Battery sizing calculations prepared by switchgear or battery manufacturer.
 - 6. Battery charger sizing calculations prepared by switchgear or battery charger Manufacturer based on no., size and load of the batteries.
 - 7. Wiring Diagrams: For each type of switchgear and related equipment, include the following:
 - a. Power, signal, and control wiring.
 - b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
 - c. Schematic control diagrams.
 - d. Diagrams showing connections of component devices and equipment.
- C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where piping and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show welded equipment support locations to embedded steel plate and the type of weld at each location. Identify field measurements.



- D. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.
- E. Manufacturer Seismic Qualification Certification: Submit certification that switchgear, accessories, and components will withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- F. Qualification Data: For professional engineer for seismic support calculations and details and testing agency.
- G. Source quality-control test reports.
- H. Field quality-control test reports.
- I. Operation and Maintenance Data: For switchgear and switchgear components to include in emergency, operation, and maintenance manuals. Include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain each type of switchgear and associated components through one source from a single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with IEEE C2.
- F. Comply with IEEE C37. 20.
- G. Manufacturer shall have UL registered ISO 9001 or 9002 certification.
- H. Manufacturer shall have the ability to supply replacement parts for a minimum period of ten (10) years from the date of completion of the project.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Switchgear shall be shipped to site by the manufacturer in closed containers, properly wrapped. Provide shock recorders on the switchgear to record any shocks suffered during transit from the factory to the jobsite.
- B. Deliver in sections of lengths that can be moved past obstructions in delivery path as indicated.



- C. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- D. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:
 - 1. Ambient temperature not exceeding 122 deg F.
 - 2. Altitude of 1000 feet above sea level.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by University or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify University Representative no fewer than ten working days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without University Representative's written permission.

1.9 COORDINATION

- A. Coordinate layout and installation of switchgear and components with other construction including conduit, piping, equipment, ductwork and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Three of each type and rating used. Include spares for future transformers, control power circuits, and fusible devices.
 - 2. Indicating Lights: Six of each type installed.
 - 3. Touchup Paint: One pint container of paint matching enclosure finish.
- B. Maintenance Tools: Furnish tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include the following:
 - 1. Fuse-handling tool.
 - 2. Extension rails, lifting device, transport or dockable dolly or mobile lift, and all other items necessary to remove circuit breaker from housing and transport to remote location.
 - 3. Racking handle to move circuit breaker manually between connected and disconnected positions, and a secondary test coupler to permit testing of circuit breaker without removal from switchgear.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Schneider Electric (Square-D)
 - b. ABB

c. Or Equal.

2.2 MANUFACTURED UNITS

- A. Description: Factory assembled and tested, and complying with IEEE C37.20.1.
- B. Ratings: Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system.
- C. System Voltage: 4.16 kV nominal

2.3 METAL-CLAD, CIRCUIT-BREAKER SWITCHGEAR

- A. Manufacturers:
 - 1. Square-D, Inc.
 - 2. ABB Control, Inc.
 - 3. Eaton Cutler Hammer, Inc.
- B. Comply with IEEE C37.20.3.
- C. Comply with IEEE C37.20.7. Provide arc-resistant switchgear, Type 2B.
- D. Nominal Interrupting-Capacity Class: 500 MVA.
- E. Ratings: Comply with IEEE C37.04.
 - 1. Maximum Design Voltage: 5 kV
 - 2. BIL Withstand: 95 kV.
 - 3. Main-Bus Rating: 1200A, continuous.
- F. Circuit Breakers: Three-pole, single-throw, electrically operated, drawout-mounting units using three individual, vacuum-sealed interrupter modules and including the following features:
 - 1. Designed to operate at rated voltage to interrupt fault current within its rating within three cycles of trip initiation. For systems with X/R ratio of 17 or less, transient voltage during interruption shall not exceed twice the rated line-to-ground voltage of the system.
 - 2. Contact-Wear Indicator: Readily accessible to field maintenance personnel.
 - 3. Minimum of six Type A and six Type B spare contacts.
 - 4. Short circuit interrupting rating shall be the same as the switchgear bus bracing.
 - 5. Interchangeability: Circuit breakers are interchangeable with vacuum circuit breakers of same current and interrupting ratings.
 - a. Current Rating of Main Circuit Breaker: 1200 A.
 - b. Continuous Current Rating of Tie Circuit Breaker: 1200 A.
 - c. Continuous Current Rating of Feeder Circuit Breaker: 1200 A.
 - 6. Operating Mechanism: Electrically charged, mechanically and electrically trip-free, stored-energy operated.
 - a. Closing speed of moving contacts to be independent of both control and operator.
 - b. Design mechanism to permit manual charging and slow closing of contacts for inspection or adjustment.
 - 1) Control Power: 48-V dc for closing and tripping.
 - c. Provide shunt trip capability independent of overcurrent trip
 - d. The charging motor for the stored-energy closing device shall be 240VAC
 - 7. Breaker stabs shall be silver plated copper, designed and fabricated to be self-aligning and to resist burning and deterioration.
- G. Enclosure:
 - 1. A totally enclosed, dead front, freestanding NEMA 1 enclosure shall be provided suitable for installation indoors and mounted on steel channels embedded in a concrete housekeeping pad.
 - 2. Stationary Structure: See Drawings for the number of sections, breaker compartments, and auxiliary compartments. Each vertical section shall be furnished with front access hinged doors and rear access hinged doors. All doors shall be provided with pistol grip lockable handles, all keyed alike.
 - a. Where "Space" is indicated, mechanically and electrically equipped space for future installation of vacuum circuit breaker shall be provided.

- b. In each vertical section, provide strip heaters, rated at 240 volts, single phase, 60 hertz and sized to operate at 120 volts. Provide a total heater rating of 2000 watts (at 240 volts) in each vertical section so that there will be 500 watts (at 120 volts) of heat while operating. Each vertical section shall be provided with both thermostat and a humidistat. Either control device shall be capable of independently activating the heaters. Each section shall also be provided with a shock detector and a humidity sensor.
 - c. During factory testing and inspection, prior to shipment a circuit breaker shall be inserted into each fully equipped space. Full testing shall be done, including but not limited to, trip, close, and test position, grounding of breaker frame during travel of rack-out procedure, and interlocking to prevent racking out of a closed breaker. All results shall be included in the Factory Test and Inspection Report.
 3. The switchgear shall be capable of extension in future from either end without requiring modification to existing structural members.
- H. Circuit Breaker Compartment:
1. Each circuit breaker compartment shall be designed to house a horizontal drawout metal-clad vacuum circuit breaker. The stationary primary disconnecting contacts shall be silver-plated copper and mounted within porcelain support bushings. The movable contacts and springs shall be mounted on the circuit breaker element for ease of inspection / maintenance.
 2. Window suitable for viewing the position of the circuit breaker in the cell and the position of the shutters with the circuit breaker out of the cell shall be provided.
 3. Entrance to the stationary primary disconnecting contacts shall be automatically covered by metal shutters when the circuit breaker is withdrawn from the connected position to the test or disconnected position or removed from the circuit breaker compartment. Extend a copper ground bus into the circuit breaker compartment to automatically ground the breaker frame with high-current spring type grounding contacts located on the breaker chassis when in the test and connected positions. Guide rails for positioning the circuit breaker and all other necessary hardware are to be an integral part of the circuit breaker compartment. Blocking devices shall interlock breaker frame sizes to prevent installation of a lower ampere rating or interrupting capacity element into a compartment designed for one of a higher rating.
 4. The drawout mechanism shall provide four (4) distinct positions of the circuit breaker (connected, disconnect, test and withdraw) and padlock provisions for locking the breaker in either the test or disconnect position. When the breaker is in the "test" position, it shall be possible to operate all the various functions of the breaker while disconnected from the switchgear distribution bus.
 5. Grounding of the breaker frame shall be maintained throughout the travel of the drawout mechanism. Interlocks shall prevent the racking out or racking in of a closed breaker.
 6. The cubicle door shall be designed so as it cannot be opened once the breaker is fully racked in.
 7. The cubicle door shall be designed so as it cannot be opened while the breaker is energized.
 8. The cubicle door shall be designed so as it can be opened only if the breaker is in the fully Disconnected or Test position.
- I. Bus Construction:
1. All current carrying components shall be of copper construction. Aluminum shall not be allowed.
 2. Main Bus:
 - a. The main bus shall be silver-plated copper and be of a bolted, not welded, design.
 - b. The main bus shall be fully insulated for its entire length with an epoxy coating by the fluidized bed process.
 - c. The main bus shall extend through all vertical sections for the full length of the equipment, and be installed with porcelain supports. Rigid polyester glass supports shall not be allowed.
 - d. Access to the main bus compartment shall be gained from the front or rear of the structure by removing a steel barrier.
 3. Neutral Bus: Not required.



- 4. Ground Bus: The ground bus shall be copper-silver plated rated at 25% of the main bus, shall extend through all vertical sections for the full length of the Equipment. The ground bus shall be of a bolted, not welded, design.
- J. Cable Connection: Terminate cables with porcelain terminators. Provide 3 sets of terminators in the main breaker cubicles, and 2 sets of terminators in all other breaker cubicles, including the spare cubicles. Terminators shall be suitable for 5/8kV, EPR, 133% rated 500MCM cable as indicated on feeder schedule.
- K. Test Accessories: Relay and meter test plugs.
- L. Low-DC-Voltage Alarm: Switchgear shall have a monitor for dc control power voltage with a remote alarm located where indicated. Alarm shall sound if voltage falls to an adjustable value to indicate an impending battery failure. Factory set alarm value at 80 percent of full-charge voltage.
- M. Circuit-Breaker Test Cabinet: Separately mounted and containing push buttons for circuit-breaker closing and tripping, control relay, fuses, and secondary coupler with cable approximately 108 inches long. Include a set of secondary devices for operating circuit breaker if removed from switchgear and moved near test cabinet. Include provision for storage of test and maintenance accessories in cabinet.

2.4 FABRICATION

- A. Indoor Enclosure: Steel.
- B. Finish: Manufacturer's standard gray finish over rust-inhibiting primer on phosphatizing-treated metal surfaces.
- C. Bus Transition Unit: Arranged to suit bus and adjacent units.
- D. Incoming-Line Unit: Arranged to suit incoming line.
- E. Outgoing Feeder Units: Arranged to suit distribution feeders.
- F. Auxiliary Compartments: Arranged to suit house meters, relays, controls, and auxiliary equipment; isolated from medium-voltage components.
- G. Key Interlocks: Arranged to effect interlocking schemes indicated.

2.5 COMPONENTS

- A. Main Bus: Copper, silver plated at connection points; full length of switchgear.
- B. Ground Bus: Copper, silver plated or copper, tin plated; minimum size 1/4 by 2 inches; full length of switchgear.
- C. Bus Insulation: Covered with flame-retardant insulation.
- D. Compression type cable lugs shall be furnished in cable compartments as shown on the single line drawings.
- E. Instrument Transformers: Comply with IEEE C57.13.
 - 1. Each breaker compartment shall have provision for front-accessible mounting of up to four current transformers per phase, two on bus side and two on cable side of circuit breaker.
 - 2. Provide all PTs and CTs as shown on the Drawings. The location of CT mounting (bus side vs line side) is essential to proper protective relaying and shall not be deviated from the drawings.
 - 3. Provide all PTs and CTs, with an accuracy of not less than 0.6%.
 - 4. Provide all PTs with 4160 volt primary and 120 volt secondary. Each PT shall be fused.
 - 5. Provide all CTs with 5 amp secondaries. Primary winding ratios shall be as indicated on the Drawings.
 - 6. Provide all CTs with shorting blocks.
 - 7. Provide all CTs with a minimum of C100 Class.
- F. Multifunction Digital Relay and Power Monitor (SEL 751 or equal) with the following features:
 - 1. Multifunction relay with overcurrent protection, negative sequence, under/over voltage, arc flash detection and neutral and phase arc flash overcurrent elements including high speed relay contacts. Program auxiliary contact 1 for maintenance mode instantaneous trip function for arc flash mitigation

- during periodic maintenance to switchgear. Comply with IEEE C37.90, integrated digital type; with test blocks and plugs.
2. Schweitzer SEL 751 digital Relays shall be provided as shown on Drawings.
 3. Schweitzer SEL 587Z digital Relays shall be provided for differential and overcurrent protection as shown on the Drawings.
 4. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
 5. Provide test switch for each PT and CT.
 6. Each vacuum circuit Breaker shall be individually equipped with Lockout Relay "Device 86" with manual reset. Trip functions from all devices shall be connected via this Lockout relay.
 7. Each circuit breaker's protective relays shall have provisions for outputs of relay failure alarm wired to the breaker's power monitoring relay inputs.
 8. Switch-selectable digital display.
 9. The substation battery voltage shall be connected to the VBAT terminals of SEL relay 751. The relay shall include two programmable threshold comparators and associated logic for battery charger fail alarm and control. The alarm shall occur, if the battery charger fails and the measured dc falls below a programmable threshold. The SEL-751 alarms shall alert operations personnel before the substation battery voltage falls to unacceptable levels.
 10. Power monitoring with sequential events recorder, oscillographic event reports, post fault diagnostics, real, reactive, apparent power and power factor metering.
 11. Communications module suitable for remote monitoring of DC power, meter quantities and functions and Interface communication and metering requirements according to Section 260913 "Electrical Power Monitoring and Control."
 12. Mounting: Display and control unit that is flush or semi-flush mounted in instrument compartment door.
- G. Analog Instruments
1. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
 2. Provide a PowerLogic Sq-D ION7550 meter with each circuit breaker as specified in section 260913 Electrical Power Monitoring to match CSUSB standards.
- H. Surge Arresters: Distribution class, metal-oxide-varistor type. Comply with NEMA LA 1.
1. Install in cable termination compartments in each phase of circuit.
 2. Coordinate rating with circuit voltage.
- I. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, wiring and bus connections.
- J. Control Power backup Supply: DC battery system.
- K. AC Control Power Supply: Control power transformer shall supply 120-V control circuits through secondary disconnect and overcurrent protection devices. Refer to drawings for size and location of CPT's.
- L. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
 2. All control wiring shall be UL listed and have a VW-1 flame retardant rating. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.
- M. Indicating Lamps: Each circuit breaker shall be provided with heavy duty, 22 millimeter LED indicating lights, with individual push to test function. The following indicating lights shall be provided:
1. Red shall indicate "BREAKER CLOSED".
 2. Green shall indicate "BREAKER OPEN".
 3. Amber shall indicate "BREAKER TRIP".

2.6 CONTROL BATTERY SYSTEM

- A. System Requirements: Battery shall have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at 25 deg C with electrolyte at normal level and minimum ambient temperature of 13 deg C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery to operate ungrounded.
- B. Battery:
 - 1. Batteries shall be Fiber Nickel Cadmium type for stationary applications as shown on drawings.
 - 2. Battery life shall be a minimum of 25years.
 - 3. Batteries shall meet the following specifications:
 - a. Operating temperature range:-40C to +60C (-40Fto +140F)
 - b. Float Charge: 1.42 to 1.45vpc
 - c. Equalize Charge: 1.52 to 1.60vpc
 - d. Recharge time to 90% available capacity: 24 hours at normal equalize voltage
 - e. Recharge currents 0.1xC5A to 0.4xC5A
 - f. Cell jar/lid: Translucent Polypropylene
 - g. Jar/Lid seal: welded, leak proof
 - h. Terminals: Nickel plated steel
 - i. Plate construction: Welded nickel plated steel and non-woven fiber plate
 - j. Electrolyte: 20% potassium hydroxide in water (S.G. 1.19 at 20C)
 - k. Recharge factor of 1.2 (instead of 1.4 as required for pocket plate batteries)
 - l. Micro-porous separators
 - 4. Designed and tested in accordance with IEC 60623
 - 5. Batteries shall be tested in accordance with IEEE 1106.
 - 6. Batteries shall be sized to provide continuous DC power for minimum of 24 hours.
 - 7. Batteries shall be sized with capability to provide DC power to future SCADA Cabinet, HMI processor, HMI screen, Ethernet switches and real time automation controller.
- C. Rack: Three Tier battery rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads. Submit Structural calculations for battery rack, cell supports, and anchorage for seismic requirements signed and stamped by a Professional Structural Engineer registered in the State of California. Provide C&D Technologies Modular Battery Rack for Liberty Series 1000 Battery or equal. Battery rack shall be designed to accommodate the battery charger.
- D. Accessories:
 - 1. Thermometers with specific-gravity correction scales.
 - 2. Hydrometer syringes.
 - 3. Set of socket wrenches and other tools required for battery maintenance.
 - 4. Wall-mounting, nonmetallic storage rack fitted to store above items.
 - 5. Set of cell numerals.
- E. Dual Chargers: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Provide temperature compensated charging voltage for thermal runaway prevention. Unit shall automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with ac input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz. Other features of charger include the following:
 - 1. DC ammeter.
 - 2. DC Voltmeter: Maximum error of 5 percent at full-charge voltage; operates with toggle switch to select between battery and charger voltages.
 - 3. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by normally open push-button contact.
 - 4. Capacity: Sufficient to supply steady load, float-charge battery and equalizing charge.

5. Charging-Rate Switch: Manually operated switch provides for transferring to higher charging rate. Charger operates automatically after switch operation until manually reset.
 6. AC power supply is 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3-Hz variation in frequency. After loss of ac power supply for any interval, charger automatically resumes charging battery. Charger regulates rate of charge to prevent damage due to overload and to prevent fuses or circuit breakers from opening.
 7. Protective Feature: Current-limiting device or circuit, which limits output current to rating of charger but does not disconnect charger from either battery or ac supply; to protect charger from damage due to overload, including short circuit on output terminals.
 8. Electrical Filtering: Reduces charger's audible noise to less than 26 dB.
 9. Output contacts for trouble and failure alarms.
- F. Provide C&D Technologies ARE-M series battery charger or equal.
- G. Plenums
1. Each arc resistant switchgear assembly shall include a plenum to direct fault gases and associated pressure wave, installed on top of the switchgear and extending over the entire length of the lineup.
 2. The plenum shall be self-supporting and attach directly to the top of the switchgear.
 3. Provide structural support for the plenum and exhaust duct for its run through the building as per manufacturers recommendation.
 4. In all cases, exhaust vents extending from the plenum to the outside shall be included with the switchgear assembly.
 5. The plenum shall be shipped separately and installed in the field.
 6. The plenum shall be constructed of heavy gauge steel in such a manner to assure integrity in the event of an arc fault.
 7. Provide exit plenum and plenum exterior wall assembly for exiting CMU wall construction along with plenum supports for exiting the switchgear per plans. Coordinate requirements with Architectural building plans.

2.7 IDENTIFICATION

- A. Materials: Refer to Section 26 05 53 "Identification for Electrical Systems." Identify units, devices, controls, and wiring.
- B. Mimic Bus: Continuous mimic bus applied to front of switchgear, arranged in single-line diagram format, using symbols and lettered designations consistent with approved final mimic-bus diagram.
1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
 2. Medium: Painted graphics, as approved.
 3. Suitable nameplates shall be included on each vertical section, identifying the manufacturers factory order, wiring diagram numbers, and ratings.
 4. Provide identification plates indicating section and feeder number on front and back of each section. Minimum size of plate shall be 3" X 5" with 1-1/2" high letters and numbers. Plate shall be black with white letters.

2.8 SOURCE QUALITY CONTROL

- A. Before shipment of equipment, perform the following tests and prepare test reports:
1. Production tests on circuit breakers according to ANSI C37.09.
 2. Production tests on completed switchgear assembly according to IEEE C37.20.2.
- B. Assemble switchgear and equipment in manufacturer's plant and perform the following:
1. Functional tests of all relays, instruments, meters, and control devices by application of secondary three-phase voltage to voltage circuits and injection of current in current transformer secondary circuits.
 2. Functional test of all control and trip circuits. Connect test devices into circuits to simulate operation of controlled remote equipment such as circuit-breaker trip coils, close coils, and auxiliary contacts. Test proper operation of relay targets.



- C. Prepare equipment for shipment.
 - 1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 - 2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

2.9 FACTORY FINISHES

- A. Finish: Manufacturer's standard color finish applied to equipment before shipping.
- B. Future Addition: Design main bus, ground bus, enclosure structure and all other necessary components for a future addition of additional vertical sections of similar design and construction to the original installation.
- C. Provide one portable automatic circuit breaker lifting device, floor-supported with a roller base multifunctional and device shall be suitable for removal of CPT from the switchgear.

PART 3 - EXECUTION

3.1 FACTORY TESTING

- A. The following tests shall be performed on the Equipment provided under this Section. All tests shall be in accordance with the latest version of ANSI, IEEE, and NEMA standards.
 - 1. Manufacturer's standard factory test.
 - 2. Dielectric Test (Hi Pot).
 - 3. Wiring check.
 - 4. Sequence of Operations.
 - 5. Testing of Arc Flash detection and control system including control of protective devices.
- B. The factory tests as outlined above shall be witnessed by the University's Representative. Contractor shall be responsible for travel, hotel accommodations, food and other reasonable expenses for three (3) University Representatives to inspect and witness testing at the factory. Include associated costs in the bid; provide a minimum of four (4) weeks advance notice prior to scheduling factory testing.
- C. Submit certified Factory Test Results and / or Inspection Results in accordance with Part 1 of this Section.

3.2 EXAMINATION

- A. Upon delivery of switchgear and prior to unloading, inspect equipment for damage.
 - 1. Examine tie rods and chains to verify they are undamaged and tight and that blocking and bracing are tight.
 - 2. Verify that there is no evidence of load shifting in transit and that readings from transportation shock recorders, are within manufacturer's recommendations.
 - 3. Examine switchgear for external damage, including dents or scratches in doors and sill, and termination provisions.
 - 4. Compare switchgear and accessories received with the bill of materials to verify that the shipment is complete. Verify that switchgear and accessories conform to the manufacturer's quotation and shop drawings. If the shipment is not complete or does not comply with project requirements, notify the manufacturer in writing immediately.
 - 5. Unload switchgear, observing packing label warnings and handling instructions.
 - 6. Open compartment doors and inspect components for damage or displaced parts, loose or broken wiring connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.
 - 7. Immediately report any discrepancies to the manufacturer and University Representative.
- B. Handling:
 - 1. Handle switchgear according to manufacturer's recommendations; avoid damage to the enclosure, termination compartments, base, frame, tank, and internal components. Do not subject switchgear to impact, jolting, jarring, or rough handling.
 - 2. Protect switchgear compartments against the entrance of dust, rain, and snow.

3. Transport switchgear upright to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip switchgear.
 4. Use spreaders or a lifting beam to obtain a vertical lift and to protect switchgear from straps bearing against the enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
 5. Do not damage structure when handling switchgear.
- C. Storage:
1. Store switchgear in a location that is clean and protected from weather. Protect switchgear from dirt, water, contamination, and physical damage. Do not store switchgear in the presence of corrosive or explosive gases.
 2. Store switchgear with compartment doors closed.
 3. Regularly inspect switchgear while in storage and maintain documentation of storage conditions, noting any discrepancies or adverse conditions.
- D. Examine rough-ins of conduits to verify the following:
1. Wiring entries comply with layout requirements.
 2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross section barriers to reach load or line lugs.
- E. Pre-installation checks:
1. Verify removal of any shipping bracing after placement.
- F. Grounding:
1. Verify that ground connections are in place and that requirements in Section 16060 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at switchgear location.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Weld switchgear assembly to channel-iron sill embedded in concrete floor base.
1. Provide Sills per plans and install level and grout flush into concrete floor base.
 2. Weld switchgear assembly to embedded steel plate and provide welds designed to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems" for seismic-restraint requirements.
 3. Concrete Bases: 6 inches high, reinforced, with chamfered edges. Extend base no less than 6 inches (75 mm) in all directions beyond the maximum dimensions of switchgear, unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.
- C. Torquing of bus ducts mounting hardware shall be field verified by the manufacturer's field service authorized technician.
- D. Minimize the bending of high-voltage cables. Bending of high-voltage cables should be avoided or minimized. All necessary bends shall meet at least the minimum radii specified by the cable manufacturer.
- E. Install equipment in accordance with manufacturer's instructions, applicable requirements of the CEC, IEEE, local building authority having jurisdiction, and in accordance with recognized industry practices.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Diagram and Instructions:
1. Frame under clear acrylic plastic on front of switchgear.
 - a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.



- b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.
2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

3.5 CONNECTIONS

- A. Cable terminations at switchgear are specified in Section 26 05 13 "Medium-Voltage Cables."
- B. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.
- C. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and Section 26 05 13 "Medium-Voltage Cables."

3.6 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 1. Inspect switchgear, wiring, components, connections, and equipment installation and test and adjust components and equipment.
 2. Report results in writing.
- C. Perform the following field tests and inspections and prepare test reports:
 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
 - a. Switchgear.
 - b. Circuit breakers.
 - c. Protective relays.
 - d. Instrument transformers.
 - e. Metering and instrumentation.
 - f. Ground-fault systems.
 - g. Battery systems.
 - h. Surge arresters.
 - i. Capacitors.
- D. Batteries shall be tested in accordance with IEEE 1106. Float effect shall be considered during battery capacity testing. With regards to battery capacity testing, it is recommended to perform first field performance test after 12 weeks on float charge without a discharge to provide a separate baseline for subsequent trending.
- E. Remove and replace malfunctioning units and retest as specified above.
- F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.
 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
 2. Instrument: Use an infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes infrared-scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.



3.7 STARTUP

- A. Any defects in electrical equipment, protective devices, wiring, or other conditions that will prevent complete coordination and the successful operation of Equipment shall be reported to the University before proceeding with the Work.
- B. All circuit interrupting devices shall be verified by the Contractor before the Equipment is energized.
- C. After the installation has been thoroughly tested and certified to be in satisfactory condition, with relays calibrated and adjusted, the Contractor shall request permission to energize the Equipment at system voltage for Operational Testing.
- D. Equipment shall not be energized until it is completely installed and ready for operation.
- E. Contractor shall hire the services of manufacturer's field service technician to field verify, check and certify all devices (e.g. relays, CBs, controls, metering, wiring, connections etc) prior to energization of the switchgear.

3.8 OPERATIONAL TESTING

- A. Submit Operational Test Procedure for approval in accordance with Part 1 of this Section.
- B. Operational Testing and infrared inspection shall be witnessed and approved by the University's Representative.
- C. Verify Equipment operates in accordance with the Sequence of Operation.

3.9 ADJUSTING

- A. Set field-adjustable, protective-relay trip characteristics according to results in Section 26 05 73 "Overcurrent Protective Device Coordination Study."

3.10 CLEANING

- A. On completion of installation, inspect interior and exterior of switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.
- B. Touch-up all paint chips and scratches with manufacturer-supplied paint and leave remaining paint with University.

3.11 PROTECTION

- A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear.

END OF SECTION 26 13 00



SECTION 26 13 10
MEDIUM VOLTAGE SOLID DIELECTRIC SWITCH

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section consists of solid dielectric insulated manually-operated load break switches and resettable vacuum fault interrupters for indoor or outdoor applications.
- B. Related Sections include the following:
 - 1. 26 05 13 "Medium-Voltage Cables" for requirements of terminating cables in incoming section of substation.
 - 2. Section 26 05 26 "Grounding and Bonding For Electrical Systems".
 - 3. Section 26 05 48 "Vibration and Seismic Controls For Electrical Systems"
- C. References:
 - 1. ANSI Standard C57.12.28 - Pad-Mounted Equipment – Enclosure Integrity
 - 2. ANSI Standard C37.60 - Overhead, Pad Mounted, Dry Vault, and Submersible Automatic Circuit Reclosers
 - 3. ANSI Standard C37.74 – Subsurface, Vault, and Pad Mounted Load Interrupter Switchgear and Fused Load Interrupter Switchgear
 - 4. ANSI Standard C37.20.3-87 (R96) Metal Enclosed Interrupter Switchgear.
 - 5. ANSI Standard C37.38-89 Gas-Insulated Metal-Enclosed Disconnecting, Interrupter, and Grounding Switches.
- D. References:
 - 1. Institute of Electrical and Electronic Engineers, Inc (IEEE) Publication:
 - a. 48-90 Standard Test Procedures and Requirements for High Voltage Alternating Current Cable Terminations
 - b. 386-85 Separable Insulated Connectors for Power Distribution Systems above 600 V
 - 2. National Electrical Manufacturer's Association (NEMA) Publication:
 - a. SG6-2000 Power Switching Equipment
 - b. National Fire Protection Association (NFPA) Publication:
 - 3. State of California Code of Regulations: Title 24, Part 3, 2016 California Electrical Code with latest amendments.

1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. GFCI: Ground-Fault Circuit Interrupter.
- C. NETA: National Electrical Testing Association.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchgear shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

- A. Product Data: Manufacturer's technical data sheets, catalog cuts for each type of switch and related equipment, include the following:



1. Rated capacities, operating characteristics, furnished accessories for load break and resettable vacuum fault interrupters.
2. Time-current characteristic curves for overcurrent protective devices.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Shop drawings shall be prepared by the factory engineer for each type of switch and related equipment, and include the following:
 1. Dimensioned plans, elevations, sections, and details to include the following:
 - a. Bill of materials.
 - b. Bus ratings
 - c. Voltage & Current characteristics.
 - d. Indicate vacuum fault interrupter ampere interrupting capacity (kA sym.)
 - e. Indicate load break switch momentary and fault close rating.
 - f. Outline and general arrangement drawing showing dimensions, weights of complete switch.
 - g. Indicate cable termination compartments showing preferred locations for conduits.
 - h. Short-time and short-circuit ratings of switch assembly.
 - i. Nameplate legends.
 - j. Three line diagram.
 2. Catalog Cuts: Manufacturer's catalog cuts for switch to include, switch and vacuum interrupter components, electronic trip units, and options and accessories.
 3. Seismic Anchor Calculations: Signed and sealed by a qualified California Registered Professional Engineer. Calculate requirements for selecting seismic anchors.
- C. Installation instructions.
- D. Factory Production test reports: Certified written reports signed by factory testing engineer or technician including their name and review comments from the testing engineer. Each report shall include date, location of tests and actual test data.
- E. Manufacturer Seismic Qualification Certification: Submit certification that switchgear, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- F. Field quality-control test reports. Submit within two (2) weeks of completion of field tests.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each switch and accessories to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE.

- A. Regulatory Requirements: Construct equipment conforming to ANSI and NEMA standards.
- B. American made products have been acceptable to the College. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the College and all tests shall be witnessed by College's personnel. All testing procedures and test results shall be satisfactory to the



College. The Contractor shall bear all costs for testing and shall be responsible for all costs associated with travel, lodging, etc. for (1) College's Representative to witness the test at the manufacturer's testing facility. The Contractor shall reimburse the Owner at \$1,200 per man day or part thereof for the time required to witness the testing. Include all costs for the above in the bid.

- C. Contractor shall ensure that the manufacturer has a minimum of 10 years' experience in the production of Medium Voltage Switches similar to the type and size specified in this project.
- D. Manufacturer shall have ISO 9001 and ISO 14001 Certification.
- E. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten years, from the date of completion of the project.
- F. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests.
- G. Field Testing Agency Qualifications:
 - 1. Testing Agency Qualifications: Testing agency shall be an independent company with the experience and capability to conduct field testing indicated; and shall test in accordance with the International Testing Association (NETA) standards.
 - 2. The company shall have permanent in-house testing engineers and technicians on its staff
 - 3. Testing company shall be located with 50 miles radius of the project.
 - 4. Field Testing technician and supervisor shall have minimum ten (10) years' experience in field testing of MV Switchgear similar to the type and rating specified on this project.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. The switch shall be shipped preassembled at the factory. No field assembly shall be required.
- B. The contractor, if applicable, shall handle, transfer and move the switches in accordance with manufacturer's recommendations.

1.9 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by College or others unless permitted in writing under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify College's Representative no fewer than fourteen (14) days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Construction Manager's written permission.
 - 3. Comply with NFPA 70E.
 - 4. Provide temporary standby power through a standby diesel quiet type back-up generator complete with fuel and 7/24 monitoring if the existing service interruption exceeds 2 hours. Coordinate additional requirements with College's Representative minimum fourteen (14) days in advance. Indicate method of providing temporary electric service.

1.10 COORDINATION

- A. Coordinate layout and installation of switchgear and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Touchup Paint: Two containers of spray paint to match enclosure finish.

1.12 WARRANTY

- A. The Contractor shall provide a complete 1 year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MANUFACTURED UNITS

- A. Description: Factory assembled and tested, and complying with IEEE C37.74.
- B. Ratings: Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system.
- C. System Voltage: 12.47 kV nominal; 15 kV maximum

2.3 MEDIUM VOLTAGE SOLID DIELECTRIC SWITCH

- A. Manufacturers:
 - 1. S&C Pad Mount to match current Campus Infrastructure.
 - 2. Or equal
- B. Comply with IEEE C37.60, C37.74, C57.12.28

2.4 SWITCH CONFIGURATION

- A. Each switch shall be equipped with 3-phase Trident load break switch ways as indicated on the one-line diagram
- B. The switch shall be designed for front access to cables and operators

2.5 SWITCH CONSTRUCTION

- A. The switch shall be a dead-front design. The operating mechanism housing shall be stainless steel with a viewing window for verification of vacuum interrupter contact position. The mechanism housing shall be painted ANSI 70 light gray using corrosion-resistant epoxy paint. Operating handles shall be padlockable and adaptable to keylock schemes. The operating shaft shall be stainless steel providing maximum corrosion resistance. A double "O" ring shaft seal shall be used for a leak resistant, long life seal.
- B. The solid dielectric modules must be coated with a semi-conductive layer of epoxy, providing a completely dead front device. The semi-conductive layer must be tested to IEEE 592 to ensure it can carry fault current to ground so as to ensure operator safety.
- C. The switch shall be designed for long term operation in the harshest environments. The interrupter design must be tested to IEC60529 and achieve a protection rating of IP68, subjected to a 10' head of water pressure for 7 days.
- D. The switch shall interrupt all load and fault currents within the vacuum bottle.
- E. Each switch mechanism shall consist of three individual vacuum bottle assemblies mechanically linked to a single spring-assisted operating mechanism. Manual opening and closing of each way shall be via an operating handle.



2.6 DESIGN RATINGS

A. Switch Ratings

SELECTION OF RATINGS (IEEE/IEC)	
Maximum Design Voltage, kV	15.5
Impulse Level (BIL) Voltage, kV	110
Continuous Current, Amperes	630A
Load break Current, Amperes	630A
One Minute Withstand (dry), AC kV	35
Production Test Rating	34
15 Minute Withstand, DC kV	53
Momentary Current, kA asymmetrical	20
Fault Close Current, kA asymmetrical	20
Fault Interrupter rating, kA asymmetrical	20
Fault Interrupter rating, kA symmetrical	12.5
Mechanical Endurance, Operations	2000

2.7 CABLE ENTRANCES

A. Load Break Switches :

1. Cable entrances shall be tested to IEEE 386 and be, as indicated on the switch drawing:
 - a. 15.5KV 110KV BIL 600A Dead break Apparatus Bushings per IEEE 386 Figure 11
2. Padmount selector switch shall be capable of having 1 set of terminators for each way. Terminators shall be suitable for 5kV, EPR, 133% rated 500MCM cable as indicated on feeder schedule.

2.8 PAD MOUNT ENCLOSURE

- A. The enclosure shall be fabricated of 12 gauge galvanized steel and manufactured to ANSI C37.72 and C57.12.28 standards. The enclosure shall be tamper resistant incorporating hinged access doors with pentahead locking bolts and provisions for padlocking. The enclosure shall be provided with lifting provisions and painted with a Munsell 7.0GY3.29/1.5 green finish.

2.9 FACTORY PRODUCTION TESTS

- A. Each interrupter shall undergo the following production testing. Test reports must be available upon request
- B. A mechanical operation check
- C. AC hi-pot tested one minute phase-to-phase, phase-to-ground and across the open contacts
- D. Circuit resistance shall be checked.
- E. Each solid dielectric module shall undergo an X-ray inspection and a partial discharge test to ensure void-free construction.
- F. Leak test to insure the integrity of all seals and gaskets
- G. Primary current injection test to test CTs, trip mechanism, and electronic control

2.10 STANDARD COMPONENTS

- A. The following shall be included as standard:
- B. Welded stainless steel mechanism housing painted light gray with stainless steel and brass fasteners.
- C. Lifting provisions
- D. 1/2"-13 nuts to provide sufficient grounding provisions for interrupter and all cable entrances.



- E. Stainless steel three-line diagram and corrosion-resistant nameplates.
- F. Switch operating handle with padlock provision.
- G. Parking stands
- H. Mounting bracket
- I. Operating handle

2.11 OPTIONS

- A. The following options shall be supplied:
- B. 4/0 brass ground lugs

2.12 LABELING

- A. Hazard Alerting Signs
 - 1. The exterior of the pad mount enclosure (if furnished) shall be provided with "Warning--Keep Out--Hazardous Voltage Inside--Can Shock, Burn, or Cause Death" signs. Each unit of switchgear shall be provided with a "Danger--Hazardous Voltage--Failure to Follow These Instructions Will Likely Cause Shock, Burn, or Death" sign. The text shall further indicate that operating personnel must know and obey the employer's work rules, know the hazards involved, and use proper protective equipment and tools to work on this equipment. Each unit of switchgear shall be provided with a "Danger--Keep Away--Hazardous Voltage--Will Shock, Burn, or Cause Death" sign.
- B. Nameplates, Ratings Labels, and Connection Diagrams
 - 1. Each unit of switchgear shall be provided with a nameplate indicating the manufacturer's name, catalog number, model number, date of manufacture, and serial number. Each unit of switchgear shall be provided with a ratings label indicating the following: voltage rating; main bus continuous rating; short-circuit rating; fault interrupter ratings including interrupting and duty-cycle fault-closing; and fault interrupter switch ratings including duty-cycle fault-closing and short-time.

2.13 SOURCE QUALITY CONTROL

- A. Before shipment of equipment, perform the following tests and prepare test reports:
 - 1. Production tests on completed switch assembly according to IEEE C37.60 & C37.74.
- B. Assemble switchgear and equipment in manufacturer's plant.
- C. Prepare equipment for shipment.
 - 1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 - 2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

2.14 FACTORY FINISHES

- A. Munsell 7.0GY3.29/15 green finish. Enclosure shall be painted with powder coated paint of minimum 2 mil thickness. Finish shall carry minimum five (5) year warranty from the manufacturer.

2.15 IDENTIFICATION

- A. Switch identification labels shall be as specified below:
 - 1. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
 - 2. Adhesive labels and nameplates are not acceptable.
- B. Mimic Bus: Continuous
- C. Mimic Bus: Continuous mimic bus applied to front of switch, arranged in single-line diagram format, using symbols and lettered designations consistent with approved final mimic-bus diagram.
 - 1. Mimic-bus segments coordinated with devices in switch to which applied, to produce a concise visual presentation of principal switch components and connections.



2. Medium: Painted graphics, as approved.
3. Color: Contrasting with factory-finish background; selected by College.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect installation for dimensions, physical damage, proper alignment, anchorage, grounding, and completeness.
- B. The contractor shall protect all equipment during delivery, storage, installation and at all times during construction.
- C. Examine elements and surfaces to receive switch for compliance with the requirements for installation tolerances, required clearances and other conditions affecting performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Installation shall conform to requirements of NFPA 70, state codes, and to requirements specified herein.
- B. Prior to submitting shop drawings and releasing order for equipment, Contractor shall verify dimensions of the available space where equipment will be installed.
- C. Install switch on existing concrete pad as indicated on drawings.
- D. Provide 15KV insulated caps on spare positions and lock in open position.
- E. Anchor switch assembly to 4-inch, channel-iron sill embedded in concrete base and attach by bolting.
 1. Sills: Select to suit switch; level and grout flush into concrete base.
 2. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 260548 "Vibration and Seismic Controls for Electrical Systems" for seismic-restraint requirements.
 3. Concrete Bases: 6 inches high, reinforced, with chamfered edges. Extend base no less than 6 inches in all directions beyond the maximum dimensions of switchgear, unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Section 260529 "Hangers and Supports for Electrical Systems."
- F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switch and components.
- G. Mounting heights shall be as follows:
 1. Control Device including switches, circuit breakers: Maximum mounting height above finished floor to the center of grip of device operating handle in its highest position shall be 6'-6" unless a lower height is required by ANSI or code.

3.3 IDENTIFICATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- E. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification. Verify requirements with College's representative.



1. Labeling Instructions:
 - a. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - c. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
2. Equipment to Be Labeled:
 - a. Medium Voltage Solid Dielectric Switches.

3.4 CONNECTIONS

- A. Cable terminations at switch shall match existing.
- B. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.
- C. Ground equipment shall match existing.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 1. Test insulation resistance for each way of the switch.
 2. Test continuity of each circuit.
- B. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- C. Perform the following field tests and inspections and prepare test reports:
 1. Perform each electrical test and visual and mechanical inspection stated in latest edition of NETA ATS, ANSI C37.74, ANSI C37.60, and IEEE 48. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
 - a. Switch.
- D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switch. Open front door so that connections are accessible to portable scanner.
 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
 2. Instrument: Use an infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 3. Record of Infrared Scanning: Prepare a certified report that identifies switch checked and that describes infrared-scanning results. Include scanned photos, notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Set field-adjustable, protective-relay trip characteristics.

3.7 CLEANING

- A. On completion of installation, inspect interior and exterior of switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.8 DEMONSTRATION

- A. Engage a factory representative to train College's maintenance personnel to adjust, operate, and maintain switch if requested by end user. Training shall be held on site after complete installation and testing of each switch.

END OF SECTION 26 13 10

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.

1.3 ACTION SUBMITTALS

- A. Product Data: Manufacturer's technical data including rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated. Include manufacturer's product data for each type of transformer and for each size specified. Highlight clearly specific information applicable to the project. Submittals with general catalogs will not be accepted and reviewed.
 - 1. K.V.A. and voltage of primary and secondary windings.
 - 2. Windings insulation class and rates temperature rise.
 - 3. Underwriters' Laboratories, Inc. (U.L.) label.
 - 4. Sound level test results of a similar transformer.
 - 5. Physical size and finish.
 - 6. Efficiency at 25, 50, 75 and 100 percent rated load.
 - 7. Windings material.
 - 8. Factory test report of ratio and polarity test.
 - 9. Factory test report of applied voltage test.
 - 10. Factory test report of induced voltage test.
 - 11. Factory test report of temperature rise at full load.
 - 12. Impedance rating and characteristics.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Qualification Data: For testing agency.
- C. Source quality-control test reports.
- D. Field quality-control test reports.



1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. American made products have been acceptable to the College. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the College and all tests shall be witnessed by College's personnel. All testing procedures and test results shall be satisfactory to the College. The Contractor shall bear all costs for testing and shall be responsible for all costs associated with travel, lodging, etc. for (1) College's Representative to witness the test at the manufacturer's testing facility. The Contractor shall reimburse the Owner at \$1,200 per man day or part thereof for the time required to witness the testing. Include all costs for the above in the bid.
- B. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of lows voltage transformers to the type and size specified in this project.
- C. Manufacturer shall have ISO 9001 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project
- E. Transformer shall be assembled at the manufacturer's own manufacturing facility using its own major devices (e.g. transformer core, windings etc.) for the assembly.
- F. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Major components (e.g., primary switch, transformer, and switchboard) shall be manufactured within six months of installation.
- G. Source Limitations: Obtain transformers through one source from a single manufacturer through a local distributor. All power distribution equipment shall be of the same manufacturer as the substation.
- H. Comply with NFPA 70.
- I. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- J. Product Options: Drawings indicate size, profiles, and dimensional requirements of secondary unit substations and are based on the specific system indicated. Refer to Part 2 "Product Requirements."
- K. Electrical Components, Devices and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100, and marked for intended use.
- L. Testing Agency Qualifications:
 - 1. Testing agency shall be an independent company with the experience to conduct field testing as indicated; shall have been a member of Inter-National Testing Association (NETA) for a minimum of last ten (10) years.
 - 2. The company shall have permanent in-house testing engineers and technicians.
 - 3. Testing company shall be located with 50 miles radius of the project.
 - 4. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
 - 5. Field Testing technician and supervisor shall have minimum ten (10) years' experience in field testing of unit substations similar to the type and rating specified on this project.
- M. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D; Schneider Electric.
 - 2. Eaton Electrical Inc.; Cutler-Hammer Products.
 - 3. General Electric Company.
 - 4. Siemens Energy & Automation, Inc.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: High grade, non aging. grain-oriented, non-aging silicon steel. I with high magnetic permeability, and low hysteresis and eddy current losses. The core of the transformer shall be visibly grounded to the enclosure by means of flexible grounding conductor sized in accordance with applicable UL and NEC standard.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil material: Copper. Basic Insulation Level (BIL) for all 600V class windings shall be 10KV.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: **[ANSI 49 gray]** **[ANSI 61 gray]**. The enclosure shall be finished utilizing a continuous process of degreasing, cleaning and phosphatizing followed by electrostatic deposition of polyester powder coating and baking.
- E. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- F. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature. The maximum temperature of the top of the enclosure shall not exceed 50°C rise above a 40°C ambient.
- G. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Comply with DOE 10 CFR Part 431 Appendix A of Subpart K 2016.
 - 2. Energy efficiency under DOE 2016 requirements is to be Energy Verified by UL.
- H. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor. K factor shall not exceed 4, 13 or 20. K factor shall be as listed on the drawings.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 - 2. Indicate value of K-factor on transformer nameplate.
- I. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.



- J. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
 - 1. 30 to 50 kVA.
 - 2. 51 to 150 kVA.
 - 3. 151 to 300 kVA.
 - 4. 301 to 500 kVA.
 - 5. 501 to 750 kVA.

2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91 at the factory prior to shipping to job site.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.
- C. Prepare and submit test report indicating actual test data within two (2) weeks of completion of tests prior to shipping to job site. Test report shall be signed by the factory test technician or engineer and include comments by the testing engineer or supervisor. Include their name, date and location

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Brace wall-mounting transformers as specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems."
- C. Transformers shall be installed at least six (6) inches from the adjacent wall or structure unless otherwise required by the manufacturer. Verify with manufacturer's installation instructions before start of work.
- D. All conduits shall be isolated from the transformer enclosures by the use of neoprene grommets at conduit entrances to enclosure and the use of a grounding bushing. Flexible jumpers shall be installed for grounding continuity from enclosure to conduits or bus ducts.
- E. Where primary feeders come from the floor below, they shall terminate at the end of transformer enclosure with a metal grounding bushing with neoprene throat insert. Ground the bushing to the transformer enclosure.

- F. Where primary feeders come from overhead, the conduits shall enter the side of the transformer enclosure. The conduits within 36 inches of the enclosure shall be flexible steel.
- G. Where transformers are installed next to an indoor switchboard, secondary conductors shall be routed from transformer to secondary switchboard through a 12-inch long wiring gutter, flanged and bolted to transformer enclosure and switchboard enclosure. Install a neoprene gasket between gutter and transformer enclosure and bond gutter to transformer enclosure with a flexible copper grounding strap.

3.3 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- D. Remove and replace units that do not pass tests or inspections and retest as specified above.
- E. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
 - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
 - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 00

**SECTION 26 23 00
LOW-VOLTAGE SWITCHGEAR**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes metal-enclosed, low-voltage power circuit-breaker switchgear rated 1000 V and less for use in ac systems.
- B. Related Sections include the following:
 - 1. Section 26 00 80 "Testing Specifications"
 - 2. Section 26 05 48 "Vibration and Seismic Controls For Electrical Systems"
 - 3. Section 26 05 73 "Overcurrent Protective Device Coordination Study" for short-circuit rating of devices and for setting of overcurrent protective devices.
 - 4. Section 26 09 13 "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
 - 5. Section 26 28 13 "Fuses."
 - 6. Section 26 43 13 "Surge Protection for Low-Voltage Electrical Power Circuits" for transient voltage surge suppressors for low-voltage power, control, and communication equipment that may be located in secondary section.

1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. GFCI: Ground-fault circuit interrupter.
- C. NETA: Inter-National Electrical Testing Association.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchgear shall withstand the effects of earthquake motions determined according to **SEI/ASCE 7**.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified **and the unit will be fully operational after the seismic event.**"

1.5 ACTION SUBMITTALS

- A. Product Data: Manufacturer's technical data and catalog cuts for each type of switchgear, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: Shop drawings prepared by the factory engineer for each type of switchgear and related equipment shall include the following information:
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:
 - a. Tabulation of installed devices with features and ratings.
 - b. Enclosure types and details.
 - c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
 - d. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
 - e. Current rating of buses.
 - f. Short-time and short-circuit current rating of switchgear assembly.
 - g. Nameplate legends.



- h. Mimic-bus diagram.
 - i. Utility company's metering provisions with indication of approval by utility company.
 - j. UL listing for series rating of installed devices.
 - k. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer installed and field installed wiring.
- C. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Ceiling and Floor plans to scale (1/4"=1'=0") showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- B. Manufacturer Seismic Qualification Certification: Submit certification that switchgear, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
- 1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports. Submit within two (2) weeks of completion of tests.
- E. Updated mimic-bus diagram reflecting field changes after final switchgear load connections have been made, for record.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchgear and components to include in emergency, operation, and maintenance manuals. include the following:
- 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- 1. Fuses: [Six] of each type and rating used. Include spares for potential transformer fuses, control power fuses, and fuses and fusible devices for fused circuit breakers.
 - 2. Indicating Lights: [Six]of each type installed.
 - 3. Touchup Paint: [3] containers of paint matching enclosure finish, each 0.5 pint.

1.9 QUALITY ASSURANCE

- A. American made products have been acceptable to the Owner. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the College and all tests shall be



witnessed by Owner's personnel. All testing procedures and test results shall be satisfactory to the Owner. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one Owner's representative to witness the test at the testing lab. Include all costs for the above in the bid.

- B. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of Switchgears similar to the type and size specified in this project. Furnish a list of minimum three (3) installations with similar equipment completed within the last five (5) years. Include name and telephone number of the facility engineer for each installation.
- C. Manufacturer shall have ISO 9001 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer indicating the above statement.
- E. Switchgear shall be assembled at the manufacturer's own manufacturing facility using its own major devices (e.g., circuit breakers) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- F. Each switchgear shall comply with seismic zone applicable to the project. Unless otherwise indicated, verify requirements with Architect or Structural Engineer of Record (SEOR). Provide certified test reports of shake table test done by manufacturer of switchgear on similar units.
- G. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Major components (e.g., primary switch, transformer, and switchboard) shall be manufactured within twelve (12) months of installation.
- H. Source Limitations: Obtain switchgear through one source from a single manufacturer through a local distributor. All power distribution equipment shall be of the same manufacturer as the substation.
- I. Comply with IEEE C37.20.1
- J. Comply with NFPA 70.
- K. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- L. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear are based on the specific system indicated.
- M. Electrical Components, Devices and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100, and marked for intended use.
- N. Testing Agency Qualifications:
 - 1. Testing agency shall be an independent company with the experience to conduct field testing as indicated; shall have been a member of Inter-National Testing Association (NETA) for a minimum of last ten (10) years.
 - 2. The company shall have permanent in-house testing engineers and technicians.
 - 3. Testing company shall be located with 50 miles radius of the project.
 - 4. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
 - 5. Field Testing technician and supervisor shall have minimum ten (10) years' experience in field testing of unit substations similar to the type and rating specified on this project.
 - 6. Refer to section 26 00 80 "Testing Specifications" for additional information.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.
- B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.



- C. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

1.11 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify College no fewer than (fourteen) 14 days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without College's written permission.
 - 3. Indicate method of providing temporary utilities. Contractor shall provide standby power if the proposed interruption is for more than two (2) hours, Include associated cost in the bid.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 40 deg C.
 - 2. Altitude: Not exceeding 6600 feet.

1.12 COORDINATION

- A. Coordinate layout and installation of switchgear and components with other construction that penetrates ceilings or is supported by them, including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.13 WARRANTY:

- A. The contractor shall provide a complete 3 year warranty, including all labor and materials. Warranty shall cover on-site repairs and replacements of defective components by manufacturer's trained technicians within 24 hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D; Schneider Electric
 - 2. Cutler-Hammer, Inc.; Eaton Corporation.
 - 3. General Electric Company.
 - 4. Siemens Energy & Automation, Inc.

2.2 RATINGS

- A. Nominal System Voltage: [480 V, 3] [480/277 V, 4] [240 V, 3] [208/120 V, 4] wire, 60 Hz.
- B. Main-Bus Continuous: [4000] [3200] [2000] [1600] A.
- C. Short-Time and Short-Circuit Current: Match rating of highest-rated circuit breaker in switchgear assembly.
- D. Switchgear and the devices shall be fully rated for the available fault current unless otherwise noted.

2.3 FABRICATION

- A. Factory assembled and tested and complying with IEEE C37.20.1.

- B. Indoor Enclosure Material: Steel.
- C. Outdoor Enclosure **[Walk-in] [Non Walk-in]** Galvanized steel. **[NEMA 4X Stainless Steel] [NEMA 3R Stainless Steel]** .
- D. Outdoor Enclosure Fabrication Requirements: Weatherproof; integral structural-steel base frame with factory-applied asphaltic undercoating; and each compartment equipped with the following features:
 - 1. Structural design and anchorage adequate to resist loads imposed by **[125-mph]** wind.
 - 2. Space heater operating at one-half or less of rated voltage, sized to prevent condensation.
 - 3. Louvers equipped with insect and rodent screen and filter; arranged to permit air circulation while excluding insects, rodents, and exterior dust.
 - 4. Hinged front door with padlocking provisions.
 - 5. Interior light with switch.
 - 6. Weatherproof duplex receptacle.
 - 7. Common internal aisle of sufficient width to permit protective-device withdrawal, disassembly, and servicing in aisle.
 - 8. Aisle access doors with outside padlocking provisions and interior panic latches.
 - 9. Aisle space heaters operating at one-half or less of rated voltage, controlled with thermostat and humidistat connected in parallel.
 - 10. Vaporproof fluorescent aisle lights with low-temperature ballasts, controlled by wall switch at each entrance.
 - 11. GFCI duplex receptacles, a minimum of two, located in aisle.
 - 12. Aisle ventilation louvers equipped with insect and rodent screen and filter and arranged to permit air circulation while excluding insects, rodents, and exterior dust.
- E. Finish: IEEE C37.20.1, manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.
- F. Section barriers between main and tie circuit-breaker compartments shall be extended to rear of section.
- G. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker.
- H. Circuit-breaker compartments shall be equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.
- I. Fabricate enclosure with removable, hinged, rear cover panels to allow access to rear interior of switchgear.
- J. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:
 - 1. Utility metering compartment that complies with utility company requirements.
 - 2. Bus transition sections.
 - 3. Incoming-line pull sections.
 - 4. Hinged front panels for access to metering, accessory, and blank compartments.
 - 5. Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and side covers and ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.
 - a. Set pull box back from front to clear circuit-breaker lifting mechanism.
 - b. Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
 - c. Cable Supports: Arranged to ease cabling and adequate to support cables indicated, including those for future installation.
- K. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.
 - 1. Main Phase Bus: Uniform capacity the entire length of assembly.
 - 2. Neutral Bus: [100] percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.



3. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
4. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
5. Phase- and Neutral-Bus Material: Silver- or tin-plated, high-strength, electrical-grade with copper circuit-breaker line connections.
6. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity or tin-plated,
7. Use silver-plated copper or tin-plated aluminum for connecting circuit-breaker line to aluminum bus.
8. Use copper for connecting circuit-breaker line to copper bus.
9. Contact Surfaces of Buses: Silver plated.
10. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
11. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 1/4 by 2 inches.
12. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
13. Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
14. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.
15. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
16. Bus-Bar Insulation: Individual bus bars or spray-applied, flame-retardant insulation.
 - a. Sprayed Insulation Thickness: 3 mils, minimum.
 - b. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

2.4 COMPONENTS

- A. Instrument Transformers: Comply with IEEE C57.13.
 1. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
 2. Current Transformers: Ratios as indicated; burden and accuracy class suitable for connected relays, meters, and instruments.
- B. Multifunction Digital-Metering Monitor: UL-listed or -recognized, microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
 2. Switch-selectable digital display of the following:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Three-Phase Real Power: Plus or minus 2 percent.
 - e. Three-Phase Reactive Power: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
 - i. Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
 3. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
- C. Analog Instruments: Rectangular, 4-1/2-inch square, accurate within 1 percent, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment, complying with ANSI C39.1.
 1. Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.

2. Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase and phase-to-neutral voltages.
 3. Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
 4. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
 5. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
 6. Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, 3 phase, 3 wire; with 3 elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
 7. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.
 - a. Operation: Meter counts and records a succession of pulses entering two channels.
 - b. Housing: Drawout, back-connected case arranged for semiflush mounting.
- D. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.
- E. Surge Arresters: Distribution class, metal-oxide-varistor type. Comply with IEEE C62.11 and NEMA LA 1.
 1. Install in cable termination compartments flush mounted on the front panel and connect in each phase of circuit.
 2. Coordinate rating with circuit voltage.
- F. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.
- G. Control Power Supply: Control power transformer supplying 120-V control circuits through secondary disconnect devices. Include the following features:
 1. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
 2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.
 - a. Secondary windings connected through a relay or relays to control bus to effect an automatic transfer scheme.
 - b. Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.
 3. Control Power Fuses: Primary and secondary fuses with current-limiting and overload protection.
 4. Fuses are specified in Section 26 28 13 "Fuses."
- H. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
 1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
 2. Conductors sized according to NFPA 70 for duty required.

2.5 CIRCUIT BREAKERS

- A. Description: Comply with IEEE C37.13.
- B. Ratings: Fully rated. As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.
- C. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
 1. Normal Closing Speed: Independent of both control and operator.
 2. Slow Closing Speed: Optional with operator for inspection and adjustment.
 3. Stored-Energy Mechanism Electrically charged, with optional manual charging.
 4. Operation counter.
- D. Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, field replaceable and the following features:



1. Functions: Field adjustable Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
 2. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
 3. Field-adjustable, time-current characteristics.
 4. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
 5. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
 6. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I²t operation.
 7. Pickup Points: Five minimum, for instantaneous-trip functions.
 8. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:
 - a. Three-wire circuit or system.
 - b. Four-wire circuit or system.
 - c. Four-wire, double-ended substation.
 9. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
- E. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.
- F. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:
 1. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
 2. Circuit-Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:
 - a. Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
 - b. Disconnected Position: Primary and secondary devices and ground contact disengaged.
- G. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.
- H. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.
- I. Operating Handle: One for each circuit breaker capable of manual operation.
- J. Electric Close Button: One for each electrically operated circuit breaker.
- K. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.
- L. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key-interlock devices is indicated.
- M. Undervoltage Trip Devices: Instantaneous, with adjustable pickup voltage.
- N. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage.
- O. Shunt-Trip Devices: Where indicated.

- P. Fused Circuit Breakers: Circuit breaker and fuse combinations complying with requirements for circuit breakers and trip devices and with the following:
 - 1. Fuses: NEMA FU 1, Class L current limiting, sized to coordinate with and protect associated circuit breaker.
 - 2. Circuit Breakers with Frame Size 1600 A and Smaller: Fuses on line side of associated circuit breaker, on a common drawout mounting, arranged so fuses are accessible only when circuit breaker is in disconnected position.
 - 3. Circuit Breakers with Frame Sizes More Than 1600 A: Fuses and circuit breakers may be installed in separate compartments on separate drawout mountings. Fuse drawout element is interlocked with associated power circuit breaker to prevent drawing out fuse element unless circuit breaker is in open position.
 - 4. Open-Fuse Trip Device: Positive means of tripping and holding circuit breaker in open position when a fuse opens. Open-fuse status is indicated at front of circuit breaker or fuse drawout element.
- Q. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

2.6 ACCESSORIES

- A. Accessory Set: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.
 - 1. Racking handle to manually move circuit breaker between connected and disconnected positions.
 - 2. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
 - 3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
 - 4. Remote racking device for racking out the breaker out of the switchgear from a distance of 30 feet (approx) from the switchgear.
- B. Circuit-Breaker Removal Apparatus for Outdoor Switchgear: Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments. The apparatus shall be located in a separate section built by the manufacturer as part of the switchgear line up.
- C. Circuit-Breaker Removal Apparatus for Indoor Switchgear: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.
- D. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.
- E. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

2.7 IDENTIFICATION

- A. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
 - 1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
 - 2. Medium: Painted graphics, as selected by Architect.
 - 3. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.
- B. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:
 - 1. Frame size of each circuit breaker.
 - 2. Trip rating for each circuit breaker.
 - 3. Conduit and wire size for each feeder.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces where switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with applicable portions of NECA 400.
- B. Anchor switchgear assembly to 4-inch, channel-iron floor sill embedded in concrete base and attach by bolting.
 - 1. Sills: Select to suit switchgear; level and grout flush into concrete base.
 - 2. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems" for seismic-restraint requirements.
 - 3. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 3 inches in all directions beyond the maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Diagram and Instructions:
 - 1. Frame and mount under clear acrylic plastic on the front of switchgear.
 - a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
 - b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.
 - 2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

3.4 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 - 1. Inspect switchgear installation, including wiring, components, connections, and equipment.
 - 2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in electrical Sections.
 - 3. Complete installation and startup checks according to manufacturer's written instructions.
 - 4. Assist in field testing of equipment including pretesting and adjusting of equipment and components.
 - 5. Report results in writing within two weeks of completion of inspection and start up checks.



- C. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- D. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each visual and mechanical inspection and electrical test stated in latest NETA ATS. Certify compliance with test parameters. Each report shall be signed by the testing technician and reviewed by the testing supervisor. Include name of testing technician and supervisor. Perform NETA tests and inspections for each of the following NETA categories:
 - a. Switchgear.
 - b. Circuit breakers.
 - c. Protective relays.
 - d. Instrument transformers.
 - e. Metering and instrumentation.
 - f. Ground-fault systems.
 - g. Battery systems.
 - h. Surge arresters.
 - i. Capacitors.
 - 2. Remove and replace malfunctioning units and retest as specified above.
- E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, scan color photos and observations after remedial action.

3.6 ADJUSTING

- A. Set field-adjustable, protective-relay trip characteristics according to results in Section 26 05 73 "Overcurrent Protective Device Coordination Study."
- B. Set field-adjustable, protective-relay trip characteristics.

3.7 CLEANING

- A. On completion of installation, inspect interior and exterior of switchgear. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 PROTECTION

- A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear.

END OF SECTION 26 23 00

SECTION 26 23 13
PARALLELING LOW AND MEDIUM-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes metal-clad, [low] [medium]-voltage, circuit-breaker switchgear rated [1000] [5000] [15000] V and less, and associated control systems, for paralleling generators on an isolated bus and for distributing power in ac systems. It will include the following features:
 - 1. **[Copper, silver-plated main bus at connection points]**
 - 2. Circuit breakers
 - 3. Communication modules.
 - 4. Meters
 - 5. Analog instruments.
 - 6. Relays.
 - 7. Control switches
 - 8. Surge arresters.
 - 9. Provisions for future devices.
 - 10. Fungus proofing.
 - 11. Control battery system, battery charger.
 - 12. Mimic bus.
- B. Related Sections include the following:
 - 1. Section 26 00 80 "Electrical Testing Specifications".
 - 2. Section 26 05 26 "Grounding and Bonding For Electrical Systems".
 - 3. Section 26 05 33 "Identification for Electrical Systems"
 - 4. Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
 - 5. Section 26 05 73 "Overcurrent Protective Device Coordination Study"
 - 6. Section 26 09 13 "Electrical Power Monitoring and Control"
 - 7. Section 26 28 13 "Fuses".

1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. GFCI: Ground-fault circuit interrupter.
- C. HMI: Human machine interface.
- D. NETA: InterNational Electrical Testing Association.
- E. SCADA: Supervisory Control And Data Acquisition

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchgear shall withstand the effects of earthquake motions determined according to [SEI/ASCE 7]
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified **and the unit will be fully operational after the seismic event.**"

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of switchgear and related equipment, include the following:

1. Manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
 2. Rated capacities, operating characteristics, furnished specialties, and accessories for individual circuit breakers.
 3. Features, characteristics, ratings, factory settings, and time-current characteristic curves for individual relays and overcurrent protective devices.
 4. Description of sequence of operation for paralleling controls.
- B. Shop Drawings: Prepared by the factory engineer for each type of switchgear and related equipment shall include the following:
1. Dimensioned plans, elevations, sections, and details drawn to scale (1/4"=1'-0"), including required clearances and service space around equipment. Include the following:
 - a. Tabulation of installed devices with features and ratings.
 - b. Enclosure types and details. Indicate space for incoming and outgoing conduits for feeders.
 - c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
 - d. Floor plan drawing showing locations for anchor bolts and leveling channels.
 - e. Bus configuration with current rating, size, and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
 - f. Short-time and short-circuit current rating of switchgear assembly.
 - g. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - h. Incoming line size.
 - i. Incoming voltage characteristics.
 - j. Indicate bus bracing in RMS Symmetrical amps.
 - k. Indicate interrupting rating of each circuit breaker in RMS symmetrical amps. (AIC).
 - l. CD containing pdf files of the complete documents.
 2. Wiring Diagrams: For switchgear, paralleling control system, and related equipment, include the following:
 - a. Power, signal, and control wiring. Differentiate between manufacturer installed and field installed wiring.
 - b. Relay controls and metering.
 - c. Schematic control diagrams.
 - d. Diagrams showing connections of component devices and equipment.
 - e. Three-line diagrams of current and future circuits showing device terminal numbers and internal diagrams.
 - f. Schematic diagrams showing connections to remote devices including SCADA remote terminal unit. Verify location, type and information about owner's existing SCADA system prior to start of work.
 3. Design Calculations: Signed and sealed by a qualified California registered professional engineer. Calculate requirements for selecting seismic restraints.
 4. Battery calculations prepared by switchgear or battery manufacturer. Include ampere hour rating of each battery, no. of CBs that will operate simultaneously, current draw by each CB.
- C. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans showing dimensioned layout drawn to scale (1/4"=1'-0"), required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.



- B. Manufacturer Seismic Qualification Certification: Submit certification that switchgear, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Qualification Data: For testing agency.
- D. Source quality-control test reports. Certified written reports signed by factory testing engineer or technician including their name and review comments from the testing engineer. Each report shall include date, location of tests and actual test data. Submit within two (2) weeks of completion of factory tests prior to shipment of switchgear.
- E. Field quality-control test reports. Submit within two (2) weeks of completion of field tests.
- F. Updated mimic bus diagram reflecting field changes after final switchgear load connections have been made, for record.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchgear and components to include in emergency, operation, and maintenance manuals. include the following:
 - 1. Manufacturer's written instructions for sequence of operation.
 - 2. Manufacturer's sample system checklists and log sheets.
 - 3. Manufacturer's written instructions for testing and adjusting relays and overcurrent protective devices.
 - 4. Time-current curves, including selectable ranges for each type of relay and overcurrent protective device.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: **[Six]** of each type and rating used. Include spares for **[potential transformers]** **[control power circuits]** **[and]** **[fusible devices]**. Fuses are specified in Section 26 28 13 "Fuses."
 - 2. Indicating Lights: **[Six]** of each type installed.
 - 3. Touchup Paint: **[3]** containers of paint matching enclosure finish, each 0.5 pint.
- B. Maintenance Tools: Furnish tools and miscellaneous items required for switchgear test, inspection, maintenance, and operation. Include the following:
 - 1. **[Floor-running transport or dockable dolly with manual lifting mechanism]** and all other items necessary to remove circuit breaker and control power transformers (CPT) from housing and transport to remote location.
 - 2. Racking handle to move circuit breaker manually between connected and disconnected positions, and a secondary test coupler to permit testing of circuit breaker without removal from switchgear.
 - 3. Provide special tools.
 - 4. Provide insulated handles tools designed for pulling fuses.
 - 5. Provide two racking and charging handles with equipment.
 - 6. Provide two keys for door locks per section.



7. Provide a test jumper cable

1.9 QUALITY ASSURANCE

- A. Regulatory Requirements: Construct equipment conforming to ANSI and NEMA standards.
- B. American made products have been acceptable to the Owner. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the Owner and all tests shall be witnessed by Owner's personnel. All testing procedures and test results shall be satisfactory to the Owner. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one Owner's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- C. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of Low and Medium Voltage Switchgear similar to the type and size specified in this project. Furnish a list of minimum three (3) installations with similar equipment completed within the last five (5) years. Include name, email and telephone number of the owner's facility engineer for each installation.
- D. Manufacturer shall have ISO 9001 Certification.
- E. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project.
- F. Switchgear shall be assembled at the manufacturer's own manufacturing facility using its own devices (e.g., circuit breakers, bus) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- G. Switchgear shall comply with seismic zone applicable to the project. Verify requirements with architect and/or structural engineer. Provide certified test reports of shake table test done by manufacturer on similar units.
- H. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Major components (e.g., primary switch, transformer, and switchboard) shall be manufactured within six months of installation.
- I. Source Limitations: Obtain switchgear through one source from a single manufacturer. All power distribution equipment shall be of a single manufacturer.
- J. Comply with IEEE C2.
- K. Comply with IEEE C37. 20.
- L. Comply with NFPA 70.
- M. Testing Agency Qualifications:
 - 1. Testing Agency Qualifications: Testing agency shall be an independent company with the experience and capability to conduct field testing indicated; shall have been a member of International Testing Association (NETA) for a minimum of last ten (10) years.
 - 2. The company shall have permanent in-house testing engineers and technicians on its staff
 - 3. Testing company shall be located with 50 miles radius of the project.
 - 4. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
 - 5. Field Testing technician and supervisor shall have minimum ten (10) years' experience in field testing of unit substations similar to the type and rating specified on this project.
 - 6. Refer to Section 26 08 00 "Testing Specifications" for additional information.
- N. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated.
- O. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100 and marked for intended use.



1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.
- B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.
- D. Follow manufacturer's recommendations for proper storage of switchgear.

1.11 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.
- B. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify College no fewer than fourteen days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Colleges's written permission.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:
 - 1. Ambient temperature not exceeding [104 deg F]

1.12 COORDINATION

- A. Coordinate layout and installation of switchgear and components with other construction that penetrates ceilings or is supported by them, including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.13 WARRANTY:

- A. The contractor shall provide a complete 3 year warranty on the complete system, including all labor and materials. Warranty shall cover on-site repairs and replacements of defective components by manufacturer's trained technicians within 24 hours of reporting by the owner.
- B. Special warranty on Batteries: In addition to the above warranty, contractor shall provide an additional minimum 10 years pro-rata warranty on lead-calcium batteries and 25 years warranty on Ni-Cad batteries. Warranty shall cover on-site repairs and replacements of defective batteries by manufacturer's trained technicians within 24 hours of reporting by the owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers specified.

2.2 GENERATOR PARALLELING MONITOR AND CONTROL SYSTEM

- A. Manufacturers:
 - 1. Russelectric.



2. Caterpillar; Engine Div.
 3. Emerson; ASCO Power Technologies, LP.
 4. GE Zenith Controls.
 5. Kohler Co.; Generator Division.
 6. Onan Corp.; Cummins Inc.; Industrial Business Group.
- B. Individual Generator Control and Monitoring Panel: Provide each generator with a control and monitoring panel that allows the operator to view status and control operation of respective generator. Provide panel with the following features and characteristics:
1. Generator Metering: 1 percent accuracy class or better.
 - a. Ammeter, Voltmeter, Frequency Meter, Wattmeter, Kilowatt-Hour Meter, and Power Factor Meter:
 - 1) For three-phase and four-wire systems, indicate line-to-line and line-to-neutral conditions on voltmeter.
 - 2) Provide analog devices for voltmeter and frequency meters.
 - 3) Provide switches or other provisions to allow reading of both generator and bus voltages and frequencies from this metering set.
 - b. Synchroscope and "Generator Set Synchronized" Indication:
 - 1) Provide lamp or LED indication of synchronization.
 - 2) Provide 360-degree analog movement synchroscope.
 - c. Engine run-time meter, start counter, rpm meter, and battery voltage meter.
 - d. Engine oil temperature gage and engine coolant temperature gage.
 2. Generator Protective and Control Switches: Provide oiltight, industrial-grade switches in generator control and monitoring panel.
 - a. Mode Selector Switch (Run/Off/Auto):
 - 1) "Run" mode to start and accelerate unit to rated speed and voltage, but not close paralleling circuit breaker.
 - 2) "Off" mode to prevent generator from starting or to immediately shutdown generator if running.
 - 3) "Auto" mode to allow generator to start on receipt of remote start signal.
 - b. Circuit-Breaker Trip/Close Switch: Interlocked with system control so that circuit-breaker closure is impossible unless the following occurs:
 - 1) Mode selector switch is in "Run" position.
 - 2) Generator set is synchronized with system bus.
 - c. Control/reset push button with flashing lamp to indicate generator is locked out due to fault condition.
 - d. Lamp test push button to simultaneously test all lamps on panel.
 - e. Control Panel Illumination: DC lamps to illuminate panel when lighting from surrounding environment is not available.
 - f. Emergency Stop Push Button: Red mushroom-head switch maintaining its position until manually reset. Provide proper label to identify it.
 - g. Voltage and Frequency Raise/Lower Switches:
 - 1) Allow plus/minus 5 percent adjustment when generator set is operating but not paralleled.
 3. Generator Protective and Control Devices: Solid-state industrial relays, integrated microprocessor-based control devices, and other accessories and devices located either in generator control and monitoring panel or in switchgear control section to provide the following features and functions:
 - a. Kilowatt Load Sharing Control:
 - 1) Operates engine governors during synchronizing and provides isochronous load sharing when paralleled.
 - 2) Allows generator set to ramp up to kilowatt load level signaled by system master controller.
 - b. Load-Demand Governing Control:



- 1) Causes generator set to ramp down to zero load when signaled to shut down in load-demand mode.
- 2) Causes generator set to ramp up to a proportional share of total bus load.
- c. Kilovolt Ampere Rating Load Sharing Control:
 - 1) Operates alternator excitation system while generator set is paralleled.
 - 2) Causes sharing of reactive load among all generator sets to within 1 percent of equal levels without voltage drop.
- d. Sync-Check and Paralleling Monitor and Control:
 - 1) Monitors and verifies that generator set has reached 90 percent of nominal voltage and frequency before closing to bus.
 - 2) Prevents out-of-phase paralleling if two or more generator sets reach operating conditions simultaneously, by sending "inhibit" signal to sets not designated by system as "first to close to bus."
 - 3) Recognizes failure of "first-to-close" generator set and signals system paralleling to continue.
 - 4) Prevents out-of-phase closure to bus due to errant manual or automatic operation of synchronizer.
- e. Synchronizer Control:
 - 1) Adjusts engine governor to match voltage, frequency, and phase angle of paralleling bus.
 - 2) Maintains generator-set voltage within 1 percent of bus voltage, and phase angle within 20 electrical degrees of paralleling bus for 0.5 seconds before circuit-breaker closing.
 - 3) Provides "fail-to-synchronize time delay" adjustable from 10 to 120 seconds; with field selectivity to either initiate alarm or shut down generator set on failure condition.
- f. Reverse Power Monitor and Control:
 - 1) Prevents sustained reverse power flow in generator set.
 - 2) Trips generator circuit breaker and initiates generator set shutdown when reverse power condition exceeds 10 percent of generator set kilowatt for three seconds.
- g. Phase Rotation Monitor and Control:
 - 1) Verifies generator set and paralleling bus phase rotation match prior to closing paralleling circuit breaker.
- h. Electronic Alternator Overcurrent Alarm and Shutdown Control:
 - 1) Monitors current flow at generator-set output terminals.
 - 2) Initiates alarm when load current on generator set is more than 110 percent of rated current for more than 60 seconds.
 - 3) Provides overcurrent shutdown function matched to thermal damage curve of alternator. Provide without instantaneous-trip function.
- i. Electronic Alternator Short-Circuit Protection:
 - 1) Provides shutdown when load current is more than 175 percent of rated current and combined time/current approaches thermal damage curve of alternator. Provide without instantaneous-trip function.
- j. Loss of Excitation Monitor:
 - 1) Initiates alarm when sensing loss of excitation to alternator while paralleled to system bus.
- k. Generator-Set Start Contacts: Redundant system, 10 A at 32-V dc.
- l. Cool-Down Time-Delay Control: Adjustable, 0 to 600 seconds.
- m. Start Time-Delay Control: Adjustable, 0 to 300 seconds.
- n. Paralleling Circuit-Breaker Monitor and Control:
 - 1) Monitors circuit-breaker auxiliary contacts.
 - 2) Initiates fault signal if circuit breaker fails to close within adjustable time-delay period (0.5 to 15 seconds).
 - 3) Trips open and locks out paralleling circuit breaker upon paralleling circuit breaker failure to close, until manually reset.

4. Engine Protection and Local Annunciation:
 - a. Provide annunciation and shutdown control modules for alarms indicated.
 - b. Provide visual alarm status indicator and alarm horn with silence/acknowledge push button on generator control and monitoring panel.
 - c. Annunciate the following conditions:
 - 1) Status, Light Only (Nonlatching):
 - a) Generator engine control switch not in auto (red).
 - b) Generator engine control switch in auto (green).
 - c) Emergency mode (red).
 - d) Generator circuit breaker closed (red).
 - e) Generator circuit breaker open (green).
 - f) Engine stopped (green).
 - g) Engine running (red).
 - h) Engine cool-down (amber).
 - 2) Pre-Alarm, Light and Horn (Nonlatching):
 - a) Pre-high coolant temperature (amber).
 - b) Pre-low oil pressure (amber).
 - c) Low coolant temperature (amber).
 - d) Engine low battery (amber).
 - e) Engine low fuel (amber).
 - f) Generator fails to synchronize (amber).
 - 3) Shutdown Alarm, Light and Horn (Latching):
 - a) Engine overcrank (red).
 - b) Engine overspeed (red).
 - c) Engine low oil pressure (red).
 - d) Engine high coolant temperature (red).
 - e) Engine low coolant level (red).
 - f) Engine remote emergency shutdown (red).
 - g) Generator circuit breaker tripped (red).
 - h) Generator loss of field (red).
 - i) Generator reverse power (red).
 - j) Generator undervoltage (red).
 - k) Generator overvoltage (red).
 - l) Generator underfrequency (red).
 - m) Generator overfrequency (red).
- C. Master Control System and Monitoring Equipment: Paralleling and monitoring equipment, components, and accessories for multiple generators with the following features and characteristics:
 1. Components and devices shall be mounted in the switchgear control section of the switchgear lineup.
 2. Paralleled System Metering: 1 percent accuracy class or better to monitor total output of generator bus.
 - a. Ammeter, voltmeter, frequency meter, wattmeter, kilowatt-hour meter, power factor meter, kilovolt ampere, kilovolt ampere rating, and kilowatt demand meters.
 - 1) For three-phase/four-wire systems, indicate line-to-line and line-to-neutral conditions on voltmeter.
 - 2) Display all functions on the HMI device.
 3. Full-Color HMI Device: Touchscreen with minimum viewing area of 60 square inches.
 - a. Allows operator to monitor and control the complete system of paralleled generator sets.
 - b. Screens shall include the following:



- 1) Main Menu: Include date, time, and system status messages with screen push buttons to access one-line diagram, system controls, load controls, alarms, bus metering, and individual generator-set data.
- 2) One-Line Diagram Screen: Depicting system configuration and system status by screen animation, screen colors, text messages, or pop-up indicators. Indicate the following minimum system conditions:
 - a) Generator sets, buses, and paralleling circuit breakers energized/de-energized.
 - b) Generator-set mode (run/off/auto).
 - c) Generator-set status (normal/warning/shutdown/load-demand stop).
 - d) Paralleling circuit-breaker status (open/closed/tripped).
 - e) Bus conditions (energized/de-energized).
 - f) Provide access to other screens.
- 3) AC Metering Screen: Displays the following minimum meter data for the paralleling bus:
 - a) Phase volts and amperes, kilowatt, kilovolt ampere, kilovolt ampere rating, power factor, frequency, kilowatt hour, and kilowatt demand.
 - b) Real-time trend chart for system kilowatts and volts updated on not less than one-second intervals.
 - c) A minimum of one historical trend chart for total system loads with intervals no shorter than five minutes and a minimum duration of four hours.
- 4) Generator-Set Control Screen: Provides control over individual generator sets from master system control panel. Includes the following minimum functions:
 - a) Generator manual start/stop control (functional only when generator-set mounted control switch is in "Auto" position).
 - b) Generator-set alarm reset.
 - c) Manual paralleling and circuit-breaker controls.
- 5) Generator-Set Data Display Screen: Provide the following minimum parameters:
 - a) Engine speed, oil pressure and temperature, coolant temperature, and engine operating hours.
 - b) Three-phase voltage and current, kilowatt, power factor, and kilowatt hour.
 - c) Generator control switch position and paralleling circuit-breaker position.
 - d) All generator-set alarms.
- 6) System Control Screen: Password protected and with the following minimum functions:
 - a) System Test Modes: Test with load/test without load/normal/retransfer time-delay override.
 - b) Test with Load: Starts and synchronizes generator sets on paralleling bus; all loads are transferred to bus.
 - c) Test without Load: Starts and synchronizes generator sets on paralleling bus but does not transfer loads to bus.
 - d) Time adjustments for retransfer time delay, transfer time delay, system time delay on stopping, and system time delay on starting.
- 7) Load-Demand Control Screen: Monitors total load on system bus and controls number of generator sets running so that capacity tracks load demand.
 - a) Load-Demand Control: On/off.
 - b) Load-Demand Pickup Set Point: Adjustable from 90 to 40 percent in 5 percent increments.
 - c) Load-Demand Dropout Set Point: Adjustable from 20 to 70 percent in 5 percent increments.
- 8) Manual Load Control Screen: Allows operator to manually add or delete generator sets from paralleled system in response to system load parameters.
 - a) Indication of system available in kilowatts and amperes.

- b) Control functions allow manual addition/removal of generator sets on system, and activation of load-shed/load-restore functions.
- 9) Load-Add/Load-Shed Sequence Screen: Password protected and with the following minimum functions:
 - a) Assigns "load-add sequence priority" to each load control relay with designation for relay operation after a set number of generator sets are online.
 - b) Assigns "load-shed sequence priority" to each load control relay with designation for relay operation depending on number of generator sets online.
- 10) Alarm Summary and Run Report Screen:
 - a) Lists most recent alarm conditions and status changes.
 - b) Lists a minimum of the most recent 32 alarm conditions by name and time/date; acknowledges alarm conditions with time/date.
 - c) For each start signal, lists start time and date, stop time and date, maximum kilowatt and ampere load on system during run time, and start and stop times of individual generator sets.
- 4. Solid-State System Status Panel:
 - a. Provides visual alarm status indicator and alarm horn with silence/acknowledge push button.
 - b. Annunciates the following conditions:
 - 1) Status, Light Only:
 - a) Running Status: Display generator set number and "green" running-status light.
 - b) Load demand mode (green).
 - c) Priority Load Status: Display load number and "green" on-status light.
 - d) System test (green).
 - e) Remote system start (red).
 - f) Normal source available (green).
 - g) Connected to normal (green).
 - h) Generator source available (green).
 - i) Connected to generator source (green).
 - 2) Status, Light and Alarm:
 - a) Load-Shed Level Status: Displays load number and red load-shed, status light.
 - b) Generator Alarm Status: Displays generator number and red "Check Generator" status light.
 - c) Controller malfunction (red).
 - d) Check station battery (red).
 - e) Bus overload (red).
 - f) System not in auto (red).
- D. Description of System Operation:
 - 1. Loss of Normal Power:
 - a. System receives "start" signal; all generator sets start and achieve rated voltage and frequency.
 - b. System closes the first generator set achieving 90 percent of rated voltage to paralleling bus.
 - c. "Priority load add" controls prevent overloading of system.
 - d. Remaining generator sets switched to synchronizers that control and then allow closure of generator sets to paralleling bus.
 - e. On closure to paralleling bus, each generator set assumes its proportional share of total load.
 - 2. Failure of a Generator Set to Start or Synchronize:
 - a. After expiration of overcrank time delay, generator set shuts down and alarm is initiated.
 - b. Priority controller prevents overload of system bus.
 - c. Manual override of priority controller at HMI allows addition of low-priority load to bus.
 - d. Bus overload monitor protects bus from manual overloading.
 - 3. Bus Overload:

- a. On bus overload, load-shed control initiates load shedding.
- b. If bus does not return to normal frequency within adjustable time period, additional load continues to be shed until bus returns to normal frequency.
- c. Loads shed can be reconnected to bus only by manual reset at HMI.
4. Load-Demand Mode:
 - a. With "load-demand" function activated, controller continuously monitors total bus load.
 - b. If bus load is below preset limits for 15 minutes, demand controller shuts down generator sets in predetermined order until minimum number of sets are operating.
 - c. On sensing available bus capacity diminished to set point, controller starts and closes generator sets to bus to accommodate load.
5. Return to Normal Power:
 - a. Process starts on removal of start signals from system.
 - b. When no load remains on paralleling bus, all generator breakers open, go through cool-down period, and shut down.
 - c. If start signal is received during cool-down period, one generator set is reconnected to bus, and system operation follows that of "loss of normal power."

2.3 MANUFACTURED UNITS

- A. Description: Factory assembled and tested and complying with IEEE C37.20.1.
- B. Ratings: Suitable for application in 3-phase, 60-Hz, solidly grounded neutral system.
- C. Indoor Enclosure Material: Steel.
- D. Outdoor Enclosure Fabrication Requirements: Walk-in type, Galvanized steel NEMA 4X Stainless Steel, weatherproof; integral structural-steel base frame with factory-applied asphaltic undercoating.
 1. Provide each compartment or group of compartments with the following features:
 - a. Structural design and anchorage adequate to resist loads imposed by 125-mph wind.
 - b. Pitched roof with slope down towards back of the gear..
 - c. Space heater operating at one-half or less of rated voltage, sized to prevent condensation. Provide control of strip heaters through factory installed thermostat and humidistat connected in parallel. Contractor shall provide power to the heaters from a branch circuit panel.
 - d. Louvers equipped with insect and rodent screen and filter; arranged to permit air circulation while excluding insects, rodents, and exterior dust.
 - e. Hinged front door with pad locking provisions.
 - f. Interior light with switch.
 - g. Weatherproof GFCI duplex receptacle.
 - h. Power for heaters, lights, and receptacles to be provided [by control power transformer.
 2. Provide weatherproof internal aisle construction with the following features:
 - a. Common internal aisle of sufficient width to permit protective-device withdrawal, disassembly, and servicing in aisle.
 - b. Aisle access doors with exterior padlocking provisions and interior panic latches.
 - c. Aisle space heaters operating at one-half or less of rated voltage, controlled with factory installed thermostat and humidistat connected in parallel..
 - d. Vaporproof fluorescent aisle lights with low-temperature ballasts, controlled by wall switch at each entrance.
 - e. GFCI duplex receptacles, a minimum of two, located in aisle.
 - f. Aisle ventilation louvers equipped with insect and rodent screen and filter; arranged to permit air circulation while excluding insects, rodents, and exterior dust.
- E. Access: Fabricate enclosure with hinged, rear cover panels to allow access to rear interior of switchgear.
- F. Finish: Manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces

- G. Phase-, Neutral-, and Ground-Bus Materials: Extend full length of switchgear.
 - 1. Phase and Neutral Bus: [Copper, silver plated at connection points]
 - 2. Ground Bus: Copper silver plated; minimum size 1/4 by 2 inches.
 - 3. Bus shall be bolted design.
- H. Switchgear Components: Incorporate components as indicated on Drawings.
 - 1. Instrument Transformers: Comply with IEEE C57.13.
 - a. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
 - b. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.
 - 2. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems, listed and labeled by UL, and with the following features:
 - a. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
 - b. Switch-selectable digital display with the following features:
 - 1) Phase Currents, Each Phase: Plus or minus 1 percent.
 - 2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - 3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - 4) Three-Phase Real Power: Plus or minus 2 percent.
 - 5) Three-Phase Reactive Power: Plus or minus 2 percent.
 - 6) Power Factor: Plus or minus 2 percent.
 - 7) Frequency: Plus or minus 0.5 percent.
 - 8) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
 - 9) Accumulated energy, in megawatt hours, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
 - c. Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements according to Section 260913 "Electrical Power Monitoring and Control."
 - d. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.
 - 3. Analog Instruments: Rectangular, 4-1/2 inches square, accurate within 1 percent; semiflush mounting, with antiparallax 250-degree scale and external zero adjustment; complying with ANSI C39.1.
 - a. Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
 - b. Voltmeter Selector Switch: Rotary type with off position; provides readings of phase-to-phase[and phase-to-neutral] voltages.
 - c. Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
 - d. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
 - e. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
 - f. Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, 3 phase, 3 wire; with 3 elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
 - g. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.
 - 1) Operation: Counts and records a succession of pulses entering two channels.
 - 2) Housing: Drawout, back-connected case arranged for semiflush mounting.
 - 4. Relays: Comply with IEEE C37.90, integrated digital type; with test blocks and plugs. Relays shall be manufactured by SEL, Basler, GE or equal.

5. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.
6. Control Power Supply: Control power transformer supplies 120-V control circuits through secondary disconnect devices. Include the following features:
 - a. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
 - b. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.
 - 1) Secondary windings connected through relay(s) to control bus to effect an automatic transfer scheme.
 - 2) Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.
 - c. Control Power Fuses: Primary and secondary fuses provide current-limiting and overload protection.
 - d. Fuses are specified in Section 26 28 13 "Fuses."
7. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
 - a. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
 - b. Conductors sized according to NFPA 70 for duty required.
- I. Identification: Electrical identification devices and installation requirements are specified in Section 26 05 53 "Identification for Electrical Systems."
 1. Identify units, devices, controls, and wiring.
 2. Mimic Bus: Continuous mimic bus, applied to front of switchgear, arranged in one-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
 - a. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
 - b. Medium: Painted graphics, as selected by Architect.
 - c. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.
- J. Control Battery System:
 1. System Requirements: Battery shall have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at 25 deg C with electrolyte at normal level and minimum ambient temperature of 13 deg C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery to operate ungrounded. Manufacturer shall ship battery to site when site is ready for installation.
 2. Battery: Lead-calcium type in sealed, clear plastic or glass containers, complete with electrolyte, fully charged, and arranged for shipment with electrolyte in cells. Limit weight of each container to not more than 70 lb and cells per container to not more than 3. System batteries shall be suitable for service at an ambient temperature ranging from minus 18 to 25 deg C. Limit variation of current output to 0.8 percent for each degree below 25 deg C down to minus 8 deg C.
 3. Battery: Nickel-Cadmium (Ni-Cad) type in sealed clear plastic containers complete with electrolyte, fully charged and arranged for shipment with electrolyte cells. Battery life shall be minimum 25 years. Provide manufacturer's warranty for 25 years.
 4. Rack: Two-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads
 5. Accessories:
 - a. Thermometers with specific-gravity correction scales.
 - b. Hydrometer syringes.
 - c. Set of socket wrenches and other tools required for battery maintenance.
 - d. Wall-mounting, nonmetallic storage rack fitted to store above items.

- e. Set of cell numerals.
- 6. Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit shall automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with ac input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz. Other features of charger include the following:
 - a. DC ammeter.
 - b. DC Voltmeter: Maximum error of 5 percent at full-charge voltage; operates with toggle switch to select between battery and charger voltages.
 - c. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, and with midpoint junction connected to ground by normally open push-button contact.
 - d. Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.33 V per cell.
 - e. Charging-Rate Switch: Manually operated switch provides for transferring to higher charging rate. Charger operates automatically after switch operation until manually reset.
 - f. AC power supply is 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3-Hz variation in frequency. After loss of ac power supply for any interval, charger automatically resumes charging battery. Charger regulates rate of charge to prevent damage due to overload and to prevent fuses or circuit breakers from opening.
 - g. Protective Feature: Current-limiting device or circuit, which limits output current to rating of charger but does not disconnect charger from either battery or ac supply; protects charger from damage due to overload, including short circuit on output terminals.
 - h. Electrical Filtering: Reduces charger's audible noise to less than 26 dB.

2.4 METAL-CLAD, CIRCUIT-BREAKER SWITCHGEAR (1000 V AND LESS)

- A. Subject to compliance with the requirements provide products from one of the following manufacturers:
 - 1. ABB Inc.
 - 2. Cutler-Hammer; Eaton Corporation.
 - 3. General Electric Company.
 - 4. Siemens Energy & Automation, Inc.
 - 5. Square D; Schneider Electric.
- B. Description: Factory assembled and tested, and complying with IEEE C37.20.1.
- C. Nominal System Voltage: [480 V, 3] [480/277 V, 4] [240 V, 3] [208/120 V, 4] wire, 60 Hz.
- D. Main-Bus Continuous: [4000] [3200] [2000] [1600] A.
- E. Short-Time and Short-Circuit Current: Match rating of highest-rated circuit breaker in switchgear assembly.
- F. Switchgear Fabrication:
 - 1. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker. Provide porcelain type barriers.
 - 2. Circuit-breaker compartments shall be equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.
 - 3. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:
 - a. Bus transition sections.
 - b. Pull sections.
 - c. Hinged front panels for access to accessory and blank compartments.
 - d. Pull box on top of switchgear for extra room for pulling cable; with removable top, front, and side covers; and ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.
 - 1) Set pull box back from front to clear circuit-breaker lifting mechanism.

- 2) Bottom: Insulating, fire-resistive material with separate holes for cable drops into switchgear.
- 3) Cable Supports: Arranged to ease cabling and adequate to support cables indicated, including those for future installation.
4. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted. Provide porcelain type barriers between where bus crosses sections.
 - a. Main Phase Bus: Bolted design. Welded design is not acceptable. Uniform capacity the entire length of assembly.
 - b. Neutral Bus: Bolted design. Welded design is not acceptable. [100] percent of phase-bus ampacity, except as indicated. Include braces for neutral-bus extensions for busway feeders.
 - c. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
 - d. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
 - e. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.
 - f. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
 - g. Access to the main bus compartment shall be gained from the front or rear of the structure by removing a steel barrier.
 - h. Bus-Bar Insulation: Individual bus bars shall be fully insulated for its entire length with an epoxy coating by fluidized bed process.
 - 1) Insulation Thickness: 3 mils, minimum.
 - 2) Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.
5. Circuit-Breaker Terminals for Cable Connections: Silver-plated copper bus extensions equipped with pressure connectors for conductors.
- G. Circuit Breakers: Comply with IEEE C37.13.
 1. Ratings: Fully rated for the available fault. Rating as indicated on drawings for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.
 2. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
 - a. Normal Closing Speed: Independent of both control and operator.
 - b. Slow Closing Speed: Optional with operator for inspection and adjustment.
 - c. Stored-Energy Mechanism: Electrically charged, with optional manual charging.
 - d. Operation counter.
 3. Trip Devices: Field replaceable and field adjustable trip units. Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:
 - a. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
 - b. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
 - c. Field-adjustable, time-current characteristics.
 - d. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
 - e. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
 - f. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I²t operation.
 - g. Pickup Points: Five minimum, for instantaneous-trip functions.

- h. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:
 - 1) Three-wire circuit or system.
 - 2) Four-wire circuit or system.
 - 3) Four-wire, double-ended substation.
 - i. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
 - 4. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two type "a" and two type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.
 - 5. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:
 - a. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed.
 - b. Circuit-Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed, unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:
 - 1) Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
 - 2) Disconnected Position: Primary and secondary devices and ground contact disengaged.
 - 6. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position; arranged to permit inspection of contacts without removing circuit breaker from switchgear.
 - 7. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.
 - 8. Operating Handle: One for each circuit breaker capable of manual operation.
 - 9. Electric Close Button: One for each electrically operated circuit breaker.
 - 10. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.
 - 11. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key-interlock devices is indicated.
 - 12. Undervoltage Trip Devices: Instantaneous, with adjustable pickup voltage.
 - 13. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage.
 - 14. Shunt-Trip Devices: Where indicated.
 - 15. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.
- H. Accessories: Furnish tools and miscellaneous items required for circuit-breaker and switchgear tests, inspections, maintenance, and operation.
 - 1. Racking handle to manually move circuit breaker between connected and disconnected positions.
 - 2. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
 - 3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
- I. Circuit-Breaker Removal Apparatus: Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers control power transformers (CPT) in and out of compartments. In outdoor switchgear, the portable floor supported CB removal apparatus shall be housed in weatherproof section built by the enclosure manufacturer as part of the switchgear lineup.
- J. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.

- K. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces where switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with applicable portions in NECA 400.
- B. Anchor switchgear assembly to 4-inch channel-iron embedded in concrete base and attach by bolting.
 - 1. Sills: Select to suit switchgear; level and grout flush into concrete base.
 - 2. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 260548 "Vibration and Seismic Controls for Electrical Systems" for seismic-restraint requirements.
 - 3. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 3 inches in all directions beyond the maximum dimensions of switchgear, unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Section 260529 "Hangers and Supports for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 260553 "Identification for Electrical Systems."
- B. Diagrams and Instructions:
 - 1. Frame and mount under clear acrylic plastic on front of switchgear.
 - a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
 - b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.
 - 2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

3.4 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Cable terminations at switchgear are specified in Section 26 05 13 "Medium-Voltage Cables."

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 - 1. Inspect switchgear installation, including wiring, components, connections, and equipment. Test and adjust components and equipment.



2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in other electrical Sections.
 3. Complete installation and startup checks according to manufacturer's written instructions.
 4. Assist in field testing of equipment including pretesting and adjusting of equipment and components.
 5. Report results in writing
- C. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports. Refer to Section 26 00 80 "Electrical Testing " for additional information.
- D. Perform the following field tests and inspections and prepare test reports:
1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
 - a. Switchgear.
 - b. Circuit breakers.
 - c. Protective relays.
 - d. Instrument transformers.
 - e. Metering and instrumentation.
 - f. Ground-fault systems.
 - g. Battery systems.
 - h. Surge arresters.
 - i. Capacitors.
 2. Remove and replace malfunctioning units and retest as specified above.
- E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.
1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include scanned photos, notation of deficiencies detected, remedial action taken, and observations after remedial action. Submit complete report including scanned photos within two weeks of completion of tests.

3.6 ADJUSTING

- A. Set field-adjustable, protective-relay trip characteristics according to results in Section 26 05 73 "Overcurrent Protective Device Coordination Study."
- B. Set field-adjustable, protective-relay trip characteristics.

3.7 CLEANING

- A. On completion of installation, inspect interior and exterior of switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.8 PROTECTION

- A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.9 DEMONSTRATION



- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear.

END OF SECTION 26 23 13

**SECTION 26 24 13
SWITCHBOARDS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Service and distribution switchboards rated 600 V and less and between 400A to 4000A
 - 2. Transient voltage suppression devices (TVSS).
 - 3. Disconnecting and overcurrent protective devices.
 - 4. Instrumentation.
 - 5. Control power.
 - 6. Accessory components and features.
 - 7. Identification.
 - 8. Mimic bus.
- B. Switchboard shall be front aligned.
- C. Related Sections include the following:
 - 1. Section 26 00 80 "Electrical Testing Specifications".
 - 2. Section 26 05 26 "Grounding and Bonding For Electrical Systems".
 - 3. Section 26 05 48 "Vibration and Seismic Controls For Electrical Systems"
 - 4. Section 26 05 53 "Identification for Electrical Systems".
 - 5. Section 26 05 73 "Overcurrent Protective Device Coordination Study" for short-circuit rating of devices and for setting of overcurrent protective devices.
 - 6. Section 26 09 13 "Electrical Power Monitoring and Control" for communication features of power distribution system devices.
 - 7. Section 26 11 16 "Secondary Unit Substations".
 - 8. Section 26 36 00 "Transfer Switches" for transfer switches that may be located in secondary distribution section.
 - 9. Section 26 43 13 "Surge Protection for Low-Voltage Electrical Power Circuits" for transient voltage surge suppressors for low-voltage power, control, and communication equipment that may be located in secondary section.
 - 10. Section 26 25 00 'Enclosed Bus Assemblies'.

1.3 DEFINITIONS

- A. NETA ATS: InterNational Electrical Testing Association - Acceptance Testing Specification.
- B. EMI: Electromagnetic interference.
- C. GFCI: Ground-fault circuit interrupter.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.
- F. AIC: Interrupting capacity (RMS symmetrical) in amperes.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."



1.5 ACTION SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required horizontal and vertical clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 - 5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
 - 6. Detail utility company's metering provisions with indication of approval by utility company.
 - 7. Include evidence of UL listing for series rating of installed devices. Series rated devices shall be provided if specified on the drawings.
 - 8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
 - 10. Include diagram and details of proposed mimic bus.
 - 11. Include schematic and wiring diagrams for power, signal, and control wiring.
- C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Ceiling and floor plans, drawn to scale (1/4"=1'-0"), on which the following items are shown and coordinated with each other, based on input from manufacturer of the items involved:
 - 1. Show structural members e.g columns, beams, doors etc. within the area where switchboards are located.
- B. Qualification Data: For qualified testing agency.
- C. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
 - 4. Submit within two (2) weeks of completion of tests.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. include the following:
 - 1. Routine maintenance requirements for switchboards and all installed components.



2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

1.9 QUALITY ASSURANCE

- A. American made products have been acceptable to the College. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the College and all tests shall be witnessed by College's personnel. Testing procedures and test results shall be satisfactory to the College. The Contractor shall bear all costs for testing and shall be responsible for all costs associated with travel, lodging, etc. for (1) College's Representative to witness the test at the manufacturer's testing facility. The Contractor shall reimburse the Owner at \$1,200 per man day or part thereof for the time required to witness the testing. Include all costs for the above in the bid.
- B. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of Switchboards similar to the type and size specified in this project.
- C. Manufacturer shall have ISO 9001 or 9002 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer confirming the availability.
- E. Switchboards shall be assembled at the manufacturer's own manufacturing facility using its own major devices (e.g., circuit breakers) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- F. Switchboard shall comply with seismic zone applicable to the project. Unless otherwise indicated, verify requirements with Architect or Structural Engineer of Record (SEOR). Provide certified test reports of shake table test done by manufacturer on similar units.
- G. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Major components (e.g., primary switch, transformer, and switchboard) shall be manufactured within six months of installation.
- H. Source Limitations: Obtain switchboards, overcurrent protective devices and accessories through one source from a single manufacturer through a local distributor unless otherwise indicated. All power distribution equipment shall be of the same manufacturer as the substation.
- I. Comply with NEMA PB 2.
- J. Comply with NFPA 70.
- K. Comply with UL 891.



- L. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- M. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchboards and are based on the specific system indicated.
- N. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100, and marked for intended location and application.
- O. Testing Agency Qualifications: Member of NETA;
 - 1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of ten (10) years and has permanent in-house testing engineers and technicians involved with testing of switchboards and OCPDs similar to those specified on this project.
 - 2. Testing company shall be located with 50 miles radius of the project.
 - 3. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
 - 4. Field Testing technician and supervisor shall have minimum ten (10) years experience in field testing of switchboards similar to the type and rating specified on this project.
- P. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products in accordance with manufacturer's recommended practices and as listed in Installation and Maintenance Manual.
- B. Each switchboard section shall be shipped in individual shipping splits for ease of handling. They shall be mounted on shipping skids and individually wrapped.
- C. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path at site.
- D. Inspect and report damage to carrier within their required time period.
- E. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- F. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage.
- G. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating 250 W per section or connect factory-installed space heaters to temporary electrical service to prevent condensation.
- H. Handle and prepare switchboards for installation according to NECA 400, NEMA PB 2.1.

1.11 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
 - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 122 deg F (50 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet (2000 m).

- D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by College or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Construction Manager and College no fewer than fourteen (14) days in advance of proposed interruption of electric service.
 2. Do not proceed with interruption of electric service without Construction Manager's and College's written permission.
 3. All utility shutdowns will be done by College's authorized personnel unless otherwise noted. Coordinate through College's Representative.
 4. Comply with NFPA 70E.
 5. Provide temporary standby power through a standby diesel quiet type back-up generator complete with fuel and 7/24 monitoring if the existing service interruption exceeds 2 hours. Coordinate additional requirements with College minimum fourteen days in advance. Indicate method of providing temporary electric service.

1.12 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.13 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings by one of the following:
1. Square D; a brand of Schneider Electric
 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
- C. Front-Connected, Front-Accessible Switchboards:
1. Main Devices: Fixed, individually mounted unless otherwise indicated.
 2. Branch Devices: Panel mounted for sizes up to 400A.
 3. Sections front and rear aligned.
- D. Front- and Side-Accessible Switchboards:
1. Main Devices: Fixed, individually mounted.
 2. Branch Devices: Panel mounted for sizes up to 400A.
 3. Sections front and rear aligned.
- E. Nominal System Voltage: 480Y/277 V or 208Y/120 V as indicated on drawings
- F. Main-Bus Continuous: As indicated on drawings.
- G. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- H. Indoor Enclosures: Steel, NEMA 250, Type 1.

- I. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- J. Outdoor Enclosures: Type 3R.
 - 1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
- K. Barriers: Between adjacent switchboard sections.
- L. Insulation and isolation for main and vertical buses of feeder sections.
- M. Cubical Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point. Provide in all switchboards located outdoors.
- N. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- O. Coordinate incoming feeder for bottom entry or top entry as per drawings.
- P. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.
- Q. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- R. Pull Box on Top of Switchboard:
 - 1. Provide a proper size (per NEC) pull box on the top of the switchboard.
 - 2. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 - 3. Set back from front to clear circuit-breaker removal mechanism.
 - 4. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
 - 5. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 - 6. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
- S. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated..
 - 2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 - 3. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 - 4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
 - 6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- T. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity (AIC) to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.



2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; field replaceable and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
- B. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 5. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 7. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- C. Insulated-Case Circuit Breaker (ICCB): 80 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
1. Fixed circuit-breaker mounting.
 2. Two-step, stored-energy closing.
 3. Standard function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time time adjustments.
 - c. Ground-fault pickup level, time delay, and I^2t response.
 4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 5. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 26 09 13 "Electrical Power Monitoring and Control."
 6. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

2.3 INSTRUMENTATION

- A. Refer to Section 26 27 13 for Metering details.

2.4 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.



- B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

2.5 IDENTIFICATION

- A. Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the front of switchboard.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NECA 400, NEMA PB 2.1.
- B. Examine switchboards before installation to verify compliance with approved shop drawings. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected to the satisfaction of the College.

3.2 INSTALLATION

- A. Install switchboards and accessories according to [NECA 400] [NEMA PB 2.1].
- B. Equipment Mounting: Install switchboards on concrete base, 6-inch nominal thickness. Comply with requirements for concrete base specified in Section 03 30 00 "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- F. Install filler plates in unused spaces of panel-mounted sections.
- G. Install overcurrent protective devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges in accordance with the recommendations of the Overcurrent Protective Device Short Circuit, Coordination and Arc Flash Study.
- H. Comply with NECA 1.

3.3 CONNECTIONS

- A. Comply with requirements for terminating feeder bus specified in Section 26 25 00 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."



- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, start-up and to assist in testing.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. All tests shall be witnessed by College's representative. Provide minimum fourteen (14) days advance notice.
 - 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 4. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front and rear panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Switchboard will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73 "Overcurrent Protective Device Coordination Study."

3.7 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.



3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train College's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 26 24 13



**SECTION 26 24 16
PANELBOARDS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details.
 - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
 - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 - 4. Detail bus configuration, current, and voltage ratings.
 - 5. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 7. Include evidence of UL listing for SPD as installed in distribution board and panelboard.
 - 8. Include wiring diagrams for power, signal, and control wiring.
 - 9. Key interlock scheme drawing and sequence of operations.
 - 10. Include time-current coordination curves for each type and rating of overcurrent protective device included in distribution board and panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.
 - 11. Wiring Diagrams: Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer-installed wiring and field-installed wiring, and between components provided by the manufacturer and those provided by others.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.



- B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. include the following:
 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Keys: Two spares for each type of panelboard cabinet lock.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.
- B. Source Limitations: Obtain distribution boards and panelboards, overcurrent protective devices and accessories through one source from a single manufacturer through a local distributor unless otherwise indicated. All power distribution equipment shall be of the same manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 FIELD CONDITIONS

- A. Environmental Limitations:
 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 1. Ambient temperatures within limits specified.
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 1. Notify Construction Manager and University no fewer than 14 days in advance of proposed interruption of electric service.
 2. Notify Construction Manager and University no fewer than 30 days in advance of proposed interruption of electric service that require shut downs that last multiple days, and require shut down of buildings.
 3. Do not proceed with interruption of electric service without Construction Manager's and Owner's written permission.
 4. Comply with NFPA 70E.

1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS



- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.
- E. Enclosures: Surface-mounted, dead-front cabinets with 2500 hour salt spray test. **All panelboards shall have double hinged covers.**
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R
 - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4
 - d. Indoor Locations Subject to Dust, Falling Dirt, and Corrosive Liquids: NEMA 250, Type 12.
 - 2. Finishes:
 - a. All steel parts shall be cleaned and zinc-phosphate pre-treatment applied prior to paint application.
 - b. Paint color shall be ANSI-61; TG1c polyester powder, applied electrostatically through air. Following paint application, parts shall be baked to produce a hard durable finish. The average thickness of the paint film shall be 2.0 mils. Paint film shall be uniform in color and free from blisters, sags, flaking and peeling.
 - c. Adequacy of paint finish to inhibit the build up of rust on ferrous metal materials shall be tested and evaluated per paragraphs 5.2.8.1-7 of ANSI C37.20.2 Salt spray withstand tests in accordance with ASTM Tenant 1654 and #B-117 shall be performed on a periodic basis at the factory to provide conformance with the corrosion resistance standard of at least 2500 hours minimum.
- F. Incoming Mains:
 - 1. Location: Convertible between top and bottom.
 - 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- G. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
 - 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
- H. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Terminations shall allow use of 75 deg C rated conductors without derating.
 - 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 - 4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
 - 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
- I. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.



1. Percentage of Future Space Capacity: Per drawings.
- J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
 1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.3 POWER PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Siemens Energy.
 2. Square D; by Schneider Electric.
 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Mains: as indicated on drawings.
- D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger than 125 A: Bolt-on circuit breakers.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Siemens Energy.
 2. Square D; by Schneider Electric.
 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: as indicated on drawings.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- F. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Siemens Energy.
 2. Square D; by Schneider Electric.
 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
- B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
 1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
 2. Fused Switch Features and Accessories:
 - a. Standard ampere ratings and number of poles.



- b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks
- C. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers for frame size up to 250A:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic Trip Circuit Breakers for frame size 400A and above.
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.
 - 4. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip). Provide in compliance with CEC requirements and indicated on drawings
 - 5. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 6. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration. Provide in compliance with CEC requirements and indicated on drawings
 - 7. Subfeed Circuit Breakers: Vertically mounted.
 - 8. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
 - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - h. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
 - i. Auxiliary Contacts: Two, SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - k. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - l. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.6 IDENTIFICATION



- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.
- D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NECA 407.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NECA 407.
- D. Equipment Mounting:
 - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
 - 2. Comply with requirements for seismic control devices specified in Section 260548 Electrical System Vibration Isolation and Seismic Restraints.
 - 3. Comply with mounting and anchoring requirements specified in Section 260548 Electrical System Vibration Isolation and Seismic Restraints.
- E. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- F. Mount panelboard cabinet plumb and rigid without distortion of box.
- G. Mounting panelboards with space behind is recommended for damp, wet, or dirty locations. The steel slotted supports in the following paragraph provide an even mounting surface and the recommended space behind to prevent moisture or dirt collection.
- H. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- I. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- J. Install filler plates in unused spaces.



3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate University's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Perform optional tests. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform University of effect on phase color coding.
 - 1. Measure loads during period of normal facility operations.
 - 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the University. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
 - 4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 24 16

SECTION 26 24 19
MOTOR-CONTROL CENTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes MCCs for use with ac circuits rated 600 V and less and having the following factory-installed components:
 - 1. Incoming main lugs and OCPDs.
 - 2. Full-voltage magnetic controllers.
 - 3. Reduced-voltage magnetic controllers.
 - 4. Reduced-voltage, solid-state controllers.
 - 5. Multispeed controllers.
 - 6. VFCs.
 - 7. Feeder-tap units.
 - 8. TVSS.
 - 9. Instrumentation.
 - 10. Auxiliary devices.
- B. Related Sections include the following:
 - 1. Section 26 00 80 "Electrical Testing Specifications".
 - 2. Section 26 28 16 Enclosed Switches and Circuit Breakers.

1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. CE: Conformance Europeene (European Compliance).
- C. CPT: Control power transformer.
- D. EMI: Electromagnetic interference.
- E. GFCI: Ground fault circuit interrupting.
- F. IGBT: Insulated-gate bipolar transistor.
- G. LAN: Local area network.
- H. LED: Light-emitting diode.
- I. MCC: Motor-control center.
- J. MCCB: Molded-case circuit breaker.
- K. MCP: Motor-circuit protector.
- L. NC: Normally closed.
- M. NO: Normally open.
- N. OCPD: Overcurrent protective device.
- O. PCC: Point of common coupling.
- P. PID: Control action, proportional plus integral plus derivative.
- Q. PT: Potential transformer.
- R. PWM: Pulse-width modulated.
- S. RFI: Radio-frequency interference.
- T. SCR: Silicon-controlled rectifier.



- U. TDD: Total demand (harmonic current) distortion.
- V. THD(V): Total harmonic voltage demand.
- W. TVSS: Transient voltage surge suppressor.
- X. VFC: Variable-frequency controller.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: MCCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

- A. Product Data: Manufacturer's technical data and catalog cuts for each type of controller and each type of MCC. Include shipping and operating weights, features, performance, electrical ratings, operating characteristics, and furnished specialties and accessories.
- B. LEED Submittals:
 - 1. Product Data for Credit EA 5: For continuous metering equipment for energy consumption.
- C. Shop Drawings: For each MCC, manufacturer's approval and production drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans to scale (1/4"=1'-0"), elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
 - 1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Factory-installed devices.
 - c. Enclosure types and details.
 - d. Nameplate legends.
 - e. Assembly ratings: Include Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit; voltage, continuous current.
 - f. Major component ratings: Include interrupting ratings, voltage and continuous current.
 - g. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
 - h. Cable terminal sizes.
 - i. Specified optional features and accessories.
 - j. Evidence of UL listing of each device. Include series rated devices if indicated on the drawings.
 - 2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for each installed controller. Include Single line diagram.
 - 3. Differentiate between manufacturer installed and field installed wiring.
 - 4. Nameplate legends.
 - 5. Vertical and horizontal bus capacities.
 - 6. Features, characteristics, ratings, and factory settings of each installed unit.
 - 7. Busway connection if applicable.
 - 8. Connection details between close coupled assemblies.
 - 9. Composite floor plan of close coupled assemblies.
 - 10. Key interlock scheme drawing and sequence of operations.
- D. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC to specified levels.



1.6 INFORMATIONAL SUBMITTALS

- A. Standard Drawings: For each MCC, as defined in UL 845.
- B. Production Drawings: For each MCC, as defined in UL 845.
- C. Coordination Drawings: Floor plans, drawn to scale (1/4"=1'-0"), showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Seismic Qualification Certificates: For MCCs, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - 4. OSHPD Special Seismic Certification (OSP) pre-approval on OSHPD projects.
- E. Qualification Data: For qualified testing agency.
- F. Product Certificates: For each MCC, from manufacturer.
- G. Source quality-control reports.
- H. Field quality-control reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
 - 4. Submit within two (2) weeks of completion of tests.
- I. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents. Size shall comply with manufacturer's recommendations and CEC.
- J. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected. Size shall comply with manufacturer's recommendations and CEC.
- K. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For MCCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. include the following:
 - 1. Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications and field-assigned wiring identification incorporated during construction by manufacturer, Contractor, or both.
 - 2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - 3. Manufacturer's written instructions for setting field-adjustable overload relays.
 - 4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage, solid-state controllers.
 - 5. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - 6. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.



1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Indicating Lights: Two of each type and color installed.
 - 4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed. Minimum one NO and NC.
 - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.9 QUALITY ASSURANCE

- A. American made products have been acceptable to the Owner. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the Owner and all tests shall be witnessed by Owner's personnel. Testing procedures and test results shall be satisfactory to the University. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one Owner's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- B. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of MCC similar to the type and size specified in this project. Provide a list of minimum three projects where such MCCs have been used within the last five (5) years. Include name, address, email and phone no of the facility engineer for each project.
- C. Manufacturer shall have ISO 9001 or 9002 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer confirming the availability.
- E. MCC shall be assembled at the manufacturer's own manufacturing facility using its own major devices (e.g., circuit breakers, MCPs, controllers) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- F. MCC shall comply with seismic zone applicable to the project. Unless otherwise indicated, verify requirements with Architect or Structural Engineer of Record (SEOR). Provide certified test reports of shake table test done by manufacturer on similar units.
- G. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Major components (e.g., controllers, breakers, transformers) shall be manufactured within six months of installation.
- H. Source Limitations: Obtain MCC, controllers, overcurrent protective devices and accessories through one source from a single manufacturer through a local distributor unless otherwise indicated. All power distribution equipment shall be of the same manufacturer as the substation unless otherwise noted.
- I. Comply with NEMA PB 2.
- J. Comply with NFPA 70.
- K. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- L. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchboards and are based on the specific system indicated. Refer to Part 2 "Product Requirements."
- M. Electrical Components, Devices, Accessories and complete assembly: UL Listed and labeled as defined in NFPA 70, Article 100, and marked for intended location and application.
- N. Testing Agency Qualifications: Member of NETA;



1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of ten (10) years and has permanent in-house testing engineers and technicians involved with testing of MCCs, OCPDs, controllers similar to those specified on this project.
 2. Testing company shall be located with 50 miles radius of the project.
 3. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
 4. Field Testing technician and supervisor shall have minimum ten (10) years experience in field testing of switchboards similar to the type and rating specified on this project.
- O. Product Selection for Restricted Space: Drawings indicate maximum dimensions for MCCs including clearances between MCCs and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- P. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver MCCs in shipping splits of lengths that can be moved past obstructions in delivery paths.
- B. Handle MCCs according to the following:
1. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."
 2. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."
- C. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside MCCs; install temporary electric heating, with at least 250 W per vertical section

1.11 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Less than 0 deg F (minus 18 deg C) or exceeding 104 deg F (40 deg C), with an average value exceeding 95 deg F (35 deg C) over a 24-hour period.
 2. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C).
 3. Humidity: Less than 95 percent (noncondensing).
 4. Altitude: Exceeding 6600 feet (2000 m), or 3300 feet (1000 m) if MCC includes solid-state devices.
- B. Interruption of Existing Electrical Service or Distribution Systems: Do not interrupt electrical service to, or distribution systems within, a facility occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify Construction Manager and University no fewer than fourteen days in advance of proposed interruption of electrical service.
 2. Indicate method of providing temporary electrical service.
 3. Do not proceed with interruption of electrical service without Construction Manager's and University's written permission.
 4. Comply with NFPA 70E.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for MCCs, including clearances between MCCs and adjacent surfaces and other items.

1.12 COORDINATION

- A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.
- B. Coordinate features of MCCs, installed units, and accessory devices with remote pilot devices and control circuits to which they connect.



- C. Coordinate features, accessories, and functions of each MCC, each controller, and each installed unit with ratings and characteristics of supply circuits, motors, required control sequences, and duty cycle of motors and loads.
- D. Coordinate size of controllers for motors to be controlled with motor suppliers.

1.13 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace TVSS, VFCs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Square D; a brand of Schneider Electric
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. General Electric Company; GE Industrial Systems.
 - 4. Rockwell Automation, Inc.; Allen-Bradley Brand.
 - 5. Siemens Energy & Automation, Inc.; Power Distribution.
- B. General Requirements for MCCs: Comply with NEMA ICS 18 and UL 845
- C. MCCs shall be totally enclosed, dead front and free standing assemblies..
- D. Minimum size of each MCC section shall be 90 inches high, 20 inches wide and 20 inches deep unless otherwise noted on the drawings.

2.2 FUNCTIONAL FEATURES

- A. Description: Modular arrangement of main units, controller units, control devices, feeder-tap units, instruments, metering, auxiliary devices, and other items mounted in vertical sections of MCC.
- B. Controller Units: Combination controller units.
 - 1. Starters shall meet applicable NEMA and UL requirements.
 - 2. Starters shall be minimum NEMA Size 1. Fractional NEMA sizes are not acceptable
 - 3. Provide a door mounted selector switch for Hand-Off-Auto operation. The Hand mode shall provide local control at the MCC unit door. In the Auto mode, control shall be provided through a remote contact.
 - 4. **HOA controllers to be equipped with LED indicator lights showing the status of each controller.**
 - 5. Install units up to and including Size 5 on draw-out mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
 - 6. All draw-out units shall be secured by a spring-loaded quarter turn indicating type fastening device located at the top of front of the unit. Each compartment shall be provided with an individual front door,
 - 7. Equip units in Type B and Type C MCCs with pull-apart terminal strips for external control connections.
- C. Feeder-Tap Units: Through 225-A rating shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
- D. Future Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.
- E. Spare Units: Installed in compartments indicated "spare." Provide two spare size 1 combination controllers complete with MCP.



2.3 INCOMING MAINS

- A. Incoming Mains Location: Top and bottom.
- B. Main Lugs Only: Conductor connectors suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Mechanical type.
- C. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes up to 250A.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip circuit breakers for frame sizes 400A and above with rms sensing; field-replaceable rating plug and field-replaceable electronic trip; and the following field-adjustable settings thru separate functions or dials:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 5. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - f. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
 - g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - h. Under-voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - i. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - k. 80 percent rated.
- D. Insulated-Case Circuit Breaker: 80 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
 - 1. Fixed circuit-breaker mounting.
 - 2. Two-step, stored-energy closing.
 - 3. Standard function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings thru separate functions or dials:
 - a. Instantaneous trip.
 - b. Long- and short-time time adjustments.
 - c. Ground-fault pickup level, time delay, and I^2t response.



4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Control Voltage: 120-V ac.

2.4 COMBINATION CONTROLLERS

- A. Full-Voltage Controllers:
 1. General Requirements for Full-Voltage Enclosed Controllers: Comply with NEMA ICS 2, general purpose, Class A.
 2. Magnetic Controllers: Full voltage, across the line, electrically held.
 - a. Configuration: Nonreversing.
 - b. Minimum size NEMA 1.
 - c. See MCC schedule on drawings for additional information.
- B. Reduced-Voltage Magnetic Controllers:
 1. General Requirements for Reduced-Voltage Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A; closed transition; adjustable time delay on transition.
 2. Reduced-Voltage Magnetic Controllers: Reduced voltage, electrically held.
 - a. Configuration:
 - b. Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
 - c. Part-Winding Controller: Separate START and RUN contactors, field-selectable for one-half or two-thirds winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
 - d. Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.
- C. Reduced-Voltage, Solid-State Controllers:
 1. General Requirements for Reduced-Voltage, Solid-State Controllers: Comply with UL 508.
 2. Reduced-Voltage, Solid-State Controllers: An integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relay; suitable for use with NEMA MG 1, Design B, polyphase, medium-induction motors.
 - a. Configuration: Standard duty, nonreversible.
 - b. Starting Mode: field selectable.
 - c. Stopping Mode: field selectable.
 - d. Shorting (Bypass) Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Solid-state controller protective features shall remain active when the shorting contactor is in the bypass mode.
 - e. Shorting and Input Isolation Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating. Provide coil transient suppressors.
 - f. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
 - g. Adjustable acceleration-rate control using voltage or current ramp, and adjustable starting torque control with up to 400 percent current limitation for 20 seconds.
 - h. SCR bridge shall consist of at least two SCRs per phase, providing stable and smooth acceleration without external feedback from the motor or driven equipment.
 - i. Keypad, front accessible; for programming the controller parameters, functions, and features; shall be manufacturer's standard and include not less than the following functions:



- j. Adjusting motor full-load amperes, as a percentage of the controller's rating.
 - k. Adjusting current limitation on starting, as a percentage of the motor full-load current rating.
 - l. Adjusting linear acceleration and deceleration ramps, in seconds.
 - m. Initial torque, as a percentage of the nominal motor torque.
 - n. Adjusting torque limit, as a percentage of the nominal motor torque.
 - o. Adjusting maximum start time, in seconds.
 - p. Adjusting voltage boost, as a percentage of the nominal supply voltage.
 - q. Selecting stopping mode, and adjusting parameters.
 - r. Selecting motor thermal-overload protection class between 5 and 30.
 - s. Activating and de-activating protection modes.
 - t. Selecting or activating communications modes.
 - u. Digital display, front accessible; for showing motor, controller, and fault status; shall be manufacturer's standard and include not less than the following:
 - v. Controller Condition: Ready, starting, running, stopping.
 - w. Motor Condition: Amperes, voltage, power factor, power, and thermal state.
 - x. Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
 - y. Controller Diagnostics and Protection:
 - z. Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor overload alarm and trip; settings selectable via the keypad.
 - aa. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency over or under normal.
 - bb. Input isolation contactor that opens when the controller diagnostics detect a faulted solid-state component, or when the motor is stopped.
 - cc. Shunt trip that opens the disconnecting means when the controller diagnostics detect a faulted solid-state component.
 - dd. Remote Output Features:
 - ee. All outputs prewired to terminal blocks.
 - ff. Form C status contacts that change state when controller is running.
 - gg. Form C alarm contacts that change state when a fault condition occurs.
 - hh. Optional Features:
 - ii. Analog output for field-selectable assignment of motor operating characteristics; 4 to 20-mA dc.
 - jj. Additional field-assignable Form C contacts for alarm outputs.
 - kk. Surge suppressors in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
 - ll. Full-voltage bypass contactor operating automatically Power contacts shall be totally enclosed, double break, and silver-cadmium oxide; and assembled to allow inspection and replacement without disturbing line or load wiring.
- D. Multispeed Magnetic Controllers:
- 1. General Requirements for Multispeed Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A.
 - 2. Multispeed Magnetic Controllers: Two speed, full voltage, across the line, electrically held. Compelling relay to ensure that motor will start only at low speed.
 - a. Configuration: Nonreversing/Reversing; **[consequent pole] [two winding]**.
 - b. Compelling relays shall ensure that motor starts only at low speed.
 - c. Accelerating timer relays shall ensure properly timed acceleration through speeds lower than that selected.
 - d. Decelerating timer relays shall ensure automatically timed deceleration through each speed.
 - e. Antiplugging timer relays shall ensure a time delay when transferring from FORWARD to REVERSE and back.



- E. Disconnecting Means and OCPDs:
 - 1. Fusible Disconnecting Means:
 - a. N/A
 - 2. MCP Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
 - d. **[NC] [NO]** alarm contact that operates only when MCP has tripped.
 - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
 - 3. MCCB Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
 - e. **[NC] [NO]** alarm contact that operates only when MCCB has tripped.
 - 4. Molded-Case Switch Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with in-line fuse block for Class J or L power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
 - d. **[NC] [NO]** alarm contact that operates only when molded-case switch has tripped.
- F. Overload Relays:
 - 1. Solid-State Overload Relays:
 - a. Switch or dial selectable for motor running overload protection.
 - b. Sensors in each phase.
 - c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
 - e. Analog communication module.
 - 2. **[NC] [NO]** isolated overload alarm contact.
 - 3. External overload reset push button.
- G. Control Power:
 - 1. Control Circuits: 120V ac; obtained from integral CPT, with primary and secondary fuses with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 100 VA.

2.5 VFCS

- A. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- B. Application: Constant torque and variable torque
- C. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by UL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
 - 1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on

- a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
 3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
 4. Listed and labeled for single-phase use by an NRTL acceptable to authorities having jurisdiction.
- D. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- E. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- F. Unit Operating Requirements:
1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of VFC input voltage rating.
 2. Input AC Voltage Unbalance: Not exceeding 5 percent.
 3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
 4. Minimum Efficiency: 96 percent at 60 Hz, full load.
 5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
 6. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
 7. Starting Torque: Minimum of 100 percent of rated torque from 3 to 60 Hz.
 8. Speed Regulation: Plus or minus 5 percent.
 9. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
 10. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
- H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.
 2. Signal: Pneumatic.
- I. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: 0.1 to 999.9 seconds.
 4. Deceleration: 0.1 to 999.9 seconds.
 5. Current Limit: 30 to a minimum of 150 percent of maximum rating.
- J. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
 2. Loss of Input Signal Protection: Selectable response strategy including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
 3. Under- and overvoltage trips.
 4. Inverter overcurrent trips.
 5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
 6. Critical frequency rejection, with three selectable, adjustable deadbands.
 7. Instantaneous line-to-line and line-to-ground overcurrent trips.
 8. Loss-of-phase protection.
 9. Reverse-phase protection.
 10. Short-circuit protection.
 11. Motor overtemperature fault.



- K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
- M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- P. Integral Input Disconnecting Means and OCPD: NEMA AB 1, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.
 - 1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
 - 2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
 - 3. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
 - 4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
 - 5. [NC] [NO] alarm contact that operates only when circuit breaker has tripped.

2.6 VFC CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicators displaying the following conditions:
 - 1. Power on.
 - 2. Run.
 - 3. Overvoltage.
 - 4. Line fault.
 - 5. Overcurrent.
 - 6. External fault.
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
 - 1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
 - 2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
 - a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
- C. Historical Logging Information and Displays:
 - 1. Running log of total power versus time.
 - 2. Total run time.
 - 3. Fault log, maintaining last **four** faults with time and date stamp for each.
- D. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters, including, but not limited to:
 - 1. Output frequency (Hz).
 - 2. Motor speed (rpm).
 - 3. Motor status (running, stop, fault).
 - 4. Motor current (amperes).
 - 5. Motor torque (percent).
 - 6. Fault or alarming status (code).
 - 7. PID feedback signal (percent).



8. DC-link voltage (V dc).
 9. Set point frequency (Hz).
 10. Motor output voltage (V ac).
- E. Control Signal Interfaces:
1. Electric Input Signal Interface:
 - a. A minimum of two programmable analog inputs: 4 to 20-mA dc.
 - b. A minimum of six multifunction programmable digital inputs.
 2. Pneumatic Input Signal Interface: 3 to 15 psig (20 to 104 kPa).
 3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
 - a. 0- to 10-V dc.
 - b. 4- to 20-mA dc.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 4. Output Signal Interface: A minimum of [one] programmable analog output signals 4- to 20-mA dc, which can be configured for any of the following:
 - a. Output frequency (Hz).
 - b. Output current (load).
 - c. DC-link voltage (V dc).
 - d. Motor torque (percent).
 - e. Motor speed (rpm).
 - f. Set point frequency (Hz).

2.7 VFC BYPASS SYSTEMS

- A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes, and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
- B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
- C. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.
- D. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
 1. Bypass Contactor: Load-break, NEMA rated contactor.
 2. Output Isolating Contactor: Non-load-break, NEMA rated contactor.
 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
- E. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.
 1. Bypass Contactor: Load-break, NEMA rated contactor.
 2. Input and Output Isolating Contactors: Non-load-break, NEMA rated contactors.
 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

- F. Bypass Contactor Configuration: Full-voltage across-the-line type.
 - 1. NORMAL/BYPASS selector switch.
 - 2. HAND/OFF/AUTO selector switch.
 - 3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
 - 4. Contactor Coils: Pressure-encapsulated type.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 - 5. Control Circuits: 120 V ac; obtained from integral CPT, with primary and secondary fuses], with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
 - 6. CPT Spare Capacity: 100 VA.
- G. Overload Relays: NEMA ICS 2.
 - 1. Solid-State Overload Relays:
 - a. Switch or dial selectable for motor-running overload protection.
 - b. Sensors in each phase.
 - c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
 - e. Analog communication module.
 - f. **[NC] [NO]** isolated overload alarm contact.
 - g. External overload reset push button.

2.8 OPTIONAL VFC FEATURES

- A. Damper control circuit with end of travel feedback capability.
- B. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.
- C. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.
- D. Firefighter's Override (Smoke Purge) Input: On a remote contact closure from smoke-control fan controller, this password-protected input:
 - 1. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).
 - 2. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.
 - 3. Forces VFC to transfer to Bypass Mode and operate motor at full speed.
 - 4. Causes display of Override Mode on the VFC display.
 - 5. Reset VFC to normal operation on removal of override signal automatically.
- E. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.
- F. Remote digital operator kit.
- G. Communication Port: RS-485 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.9 FEEDER-TAP UNITS

- A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.



3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
 6. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - f. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
 - g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - i. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- B. Fusible Switch: NEMA KS 1, Type HD, clips to accommodate specified fuses with lockable handle.
- C. Fuses are specified in Section 262813 "Fuses."

2.10 TRANSIENT VOLTAGE SUPPRESSION DEVICES

- A. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, bolt-on, solid-state, parallel-connected, modular with field-replaceable modules type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the MCC short-circuit rating, and with the following features and accessories:
1. Fuses, rated at 200-kA interrupting capacity.
 2. Fabrication using bolted compression lugs for internal wiring.
 3. Integral disconnect switch.
 4. Redundant suppression circuits.
 5. Redundant replaceable modules.
 6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 7. LED indicator lights for power and protection status.
 8. Audible alarm, with silencing switch, to indicate when protection has failed.
 9. Form-C contacts rated at 5 A and 250-V ac, one NO and one NC, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 10. [Four] [Six]-digit, transient-event counter set to totalize transient surges.
- B. Peak Single-Impulse Surge Current Rating: 80 kA per mode/160 kA per phase.

- C. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
- D. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall be as follows:
 - 1. Line to Neutral: 800 V for 480Y/277.
 - 2. Line to Ground: 800 V for 480Y/277.
 - 3. Neutral to Ground: 800 V for 480Y/277.
- E. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:
 - 1. Line to Neutral: 400 V, 800 V from high leg.
 - 2. Line to Ground: 400 V.
 - 3. Neutral to Ground: 400 V.
- F. Protection modes and UL 1449 SVR for 240-, 480-, or 600-V, three-phase, three-wire, delta circuits shall be as follows:
 - 1. Line to Line: 2000 V for 480 V
 - 2. Line to Ground: 1500 V for 480 V

2.11 MCC CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from CPT.
- B. Control Circuits: 120-V ac, supplied from remote branch circuit.
- C. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.12 ENCLOSURES

- A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, Type 12 unless otherwise indicated to comply with environmental conditions at installed location.
- B. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
 - 1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
 - 2. Space-Heater Power Source: Transformer, factory installed in MCC.
- C. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- D. Compartments: Modular; individual lift-off doors with concealed hinges and quick-captive screw fasteners. Interlocks on units requiring disconnecting means in off position before door can be opened or closed, except by operating a permissive release device.
- E. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
- F. Wiring Spaces:
 - 1. Vertical wire ways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
 - 2. Horizontal wire ways in bottom and top of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.



2.13 AUXILIARY DEVICES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
 - 1. Push Buttons, Pilot Lights, and Selector Switches: Heavy duty.
 - a. Push Buttons: Shrouded types; momentary contact unless otherwise indicated.
 - b. Pilot Lights: LED types.
 - c. Selector Switches: Rotary type.
 - 2. Elapsed-Time Meters: Heavy duty with digital readout in hours; resettable.
 - 3. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy with selector switches having an off position.
- B. Reversible NC/NO contactor auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable **solid-state** time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
- E. Space heaters, with NC auxiliary contacts, to mitigate condensation in enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- F. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- G. Cover gaskets for Type 1 enclosures.
- H. Spare control-wiring terminal blocks unwired.
- I. Spare-Fuse Cabinet: Identified cabinet with hinged lockable door.

2.14 CHARACTERISTICS AND RATINGS

- A. Wiring: NEMA ICS 18, Class I, Type B, for starters above Size 3 Type B-T, for starter Size 3 and below.
- B. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
- C. Nominal System Voltage: 480Y/277 V, three phase, four wire.
- D. Short-Circuit Current Rating for Each Unit: Fully rated; 42 kA. Verify maximum available fault level from the Short Circuit and Coordination Study.
- E. Short-Circuit Current Rating of MCC: Fully rated with its main overcurrent device; 42 kA. Verify maximum available fault level from the Short Circuit and Coordination Study.
- F. Environmental Ratings:
 - 1. Ambient Temperature Rating: Not less than 0 deg F (minus 18 deg C) and not exceeding 104 deg F (40 deg C), with an average value not exceeding 95 deg F (35 deg C) over a 24-hour period.
 - 2. Ambient Storage Temperature Rating: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
 - 3. Humidity Rating: Less than 95 percent (noncondensing).
 - 4. Altitude Rating: Not exceeding 6600 feet (2000 m), or 3300 feet (1000 m) if MCC includes solid-state devices.
- G. Main-Bus Continuous Rating: 1200 A.
- H. Vertical-Bus Minimum Continuous Rating: 600 A.
- I. Horizontal and Vertical Bus Bracing (Short-Circuit Current Rating): Match MCC short-circuit current rating
- J. In "Main Horizontal and Equipment Ground Buses" Paragraph below, indicate location of future extensions on Drawings if not retaining first option.

- K. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions from both ends. Brace bus extensions for busway.
- L. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.
- M. Phase and Neutral Bus Material: Hard-drawn copper of 98 percent conductivity, Tin plated.
- N. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- O. Ground Bus: Minimum size required by UL 845, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit equipment grounding conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
- P. Front-Connected, Front-Accessible MCCs:
 - 1. Main Devices: Fixed mounted.
 - 2. Controller Units: Drawout mounted.
 - 3. Feeder-Tap Units: Drawout mounted.
 - 4. Sections front and rear aligned.
- Q. Bus Transition and Incoming Pull Sections: Matched and aligned with basic MCC.
- R. Pull Box on Top of an MCC:
 - 1. Adequate ventilation to maintain temperature in pull box within same limits as MCC.
 - 2. Set back from front to clear circuit-breaker removal mechanism.
 - 3. Removable covers forming top, front, and sides. Top covers at rear easily removable for drilling and cutting.
 - 4. Insulated bottom of fire-resistive material with separate holes for cable drops into MCC.
 - 5. Cable supports arranged to facilitate cabling and adequate to support cables, including those for future installation.
 - 6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- S. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of unit.
- T. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.
- U. Fungus Proofing: Permanent fungicidal treatment for OCPDs and other components including instruments and instrument transformers.

2.15 SOURCE QUALITY CONTROL

- A. MCC Testing: Inspect and test MCCs according to requirements in NEMA ICS 18.
- B. The motor control centers shall be tested in a manufacturer's high-power laboratory to prove adequate mechanical and electrical capabilities.
- C. All factory tests required by the latest ANSI, NEMA and UL standards shall be performed.
- D. A certified test report of all standard production tests shall be submitted within two (2) weeks of completion of tests.
- E. The owner's representative shall witness factory tests as outlined above. The manufacturer shall notify the owner minimum four (4) weeks prior to the date the tests are to be performed.
- F. VFC Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2
 - 1. Test each VFC while connected to its specified motor.
 - 2. Verification of Performance: Rate VFCs according to operation of functions and features specified.
- G. MCCs will be considered defective if they do not pass tests and inspections.

- H. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive MCCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HARMONIC ANALYSIS STUDY

- A. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at the defined PCC to specified levels.
- B. Prepare a harmonic analysis study report complying with IEEE 399 and NETA Acceptance Testing Specification.

3.3 INSTALLATION

- A. Coordinate layout and installation of MCC with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Floor-Mounting Controllers: Install MCC on existing concrete base.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in each fusible switch.
- F. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."
- G. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- I. Comply with NECA 1.

3.4 IDENTIFICATION

- A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems" for identification of MCC, MCC components, and control wiring.
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label MCC and each cubicle with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.
 - 4. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.



- B. Operating Instructions: Frame printed operating instructions for MCCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of MCCs.

3.5 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices and facility's BAS and facility's central-control system. Comply with requirements in Section 26 05 23 "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
 - 2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

- A. Comply with requirements for installation of conduit in Section 26 05 33 "Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- E. Tests and Inspections:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each enclosed controller element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at controller locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multipole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multipole enclosed controller 11 months after date of Substantial Completion.



- c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
 - 10. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.
- F. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.8 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- 1. Complete installation and startup checks according to manufacturer's written instructions.

3.9 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager and University before increasing settings.
- D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.
- E. Program microprocessors in VFCs for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- F. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73 "Overcurrent Protective Device Coordination Study."

3.10 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train University's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage, solid-state controllers at no extra cost to the University.

END OF SECTION 26 24 19

**SECTION 26 25 00
ENCLOSED BUS ASSEMBLIES**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Feeder-bus assemblies 120/208V, 277/480V.
- B. Related Sections include the following:
 - 1. Section 26 05 26 "Grounding and Bonding for Electrical Systems.
 - 2. Section 26 05 29 - Hangers and Supports for Electrical
 - 3. Section 26 05 53 "Identification for Electrical Systems".
 - 4. Section 26 05 72 "Overcurrent Protective Device Short Circuit Study".
 - 5. Section 26 05 73 "Overcurrent Protective Device Coordination Study".

1.3 DEFINITIONS

- A. TVSS: Transient voltage surge suppressor.
- B. NETA: InterNational Electrical Testing Association.

1.4 ACTION SUBMITTALS

- A. Shop Drawings: For each type of bus assembly and plug-in device.
 - 1. Show fabrication and installation details for enclosed bus assemblies. Include plans, elevations, and sections of components. Designate components and accessories, including clamps, brackets, hanger rods, connectors, straight lengths, and fittings.
 - 2. Show fittings, materials, fabrication, and installation methods for listed fire-stop barriers and weather barriers.
 - 3. Indicate required clearances, method of field assembly, and location and size of each field connection.
 - 4. Detail connections to switchgear, switchboards, transformers, and panelboards.
 - 5. Wiring Diagrams: Power wiring.
 - 6. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer.
 - a. Design Calculations: Calculate requirements for selecting seismic restraints.
 - b. Detail fabrication, including anchorages and attachments to structure and to supported equipment.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and sections, drawn to scale (1/4"=1'-0"). Include scaled bus-assembly layouts and relationships between components and adjacent structural, mechanical, and electrical elements. Show the following:
 - 1. Vertical and horizontal enclosed bus-assembly runs, offsets, and transitions.
 - 2. Clearances for access above and to the side of enclosed bus assemblies.
 - 3. Vertical elevation of enclosed bus assemblies above the floor or bottom of structure.
 - 4. Support locations, type of support, and weight on each support.
- B. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.
- C. Qualification Data: For professional engineer and testing agency.
- D. Product Certificates: For each type of enclosed bus assembly, signed by product manufacturer.



- E. Manufacturer Seismic Qualification Certification: Submit certification that enclosed bus assemblies, plug-in devices, accessories, and components will withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- F. Source quality-control reports:
 - 1. Standard factory tests shall be performed on the equipment provided under this section. All tests shall be done at the manufacturing facility in accordance with the latest version of ANSI and NEMA standards.
 - 2. Furnish three (3) certified copies of factory test reports signed by factory technician and reviewed and signed by the testing engineer. Include date and location of tests.
 - 3. Submit within two weeks of completion of tests prior to shipment to job site.
- G. Field quality-control test reports. Submit test report within two (2) weeks of completion of tests.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed bus assemblies to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.8 QUALITY ASSURANCE

- A. American made products have been acceptable to the Owner. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the Owner and all tests shall be witnessed by Owner's personnel. Testing procedures and test results shall be satisfactory to the Owner. The Contractor shall bear all costs for testing and shall be responsible for all costs associated with travel, lodging, etc. for (1) University's Representative to witness the test at the manufacturer's testing facility. The Contractor shall reimburse the Owner at \$1,200 per man day or part thereof for the time required to witness the testing. Include all costs for the above in the bid.
- B. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of Enclosed Busways similar to the type and size specified in this project.
- C. Manufacturer shall have ISO 9001 or 9002 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer confirming the availability.
- E. Busways shall be assembled at the manufacturer's own manufacturing facility using its own major components (e.g., bus. circuit breakers, disconnects etc) for the assembly.
- F. Busways shall comply with seismic zone applicable to the project. Unless otherwise indicated, verify requirements with Architect or Structural Engineer of Record (SEOR). Provide certified test reports of shake table test done by manufacturer on similar units.
- G. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Busways shall be manufactured within six months of installation.



- H. Source Limitations: Obtain busways, overcurrent protective devices and accessories through one source from a single manufacturer through a local distributor unless otherwise indicated. All power distribution equipment shall be of the same manufacturer as the other power distribution equipment on this project unless otherwise noted.
- I. Comply with NFPA 70.
- J. Comply with NEMA BU 1, Busways.
- K. Comply with UL 857.
- L. Installer Qualifications: An employer of workers qualified as defined in NEMA and trained in electrical safety as required by NFPA 70E.
- M. Product Options: Drawings indicate size, profiles, and dimensional requirements of busways and are based on the specific system indicated
- N. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100 and marked for intended location and application.
- O. Testing Agency Qualifications:
 - 1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of last ten (10) years and has permanent in-house testing engineers and technicians involved with testing of busways and OCPDs similar to those specified on this project.
 - 2. Testing company shall be located with 50 miles radius of the project.
 - 3. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
 - 4. Field Testing technician and supervisor shall have minimum ten (10) years experience in field testing of busways similar to the type and rating specified on this project.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle enclosed bus assemblies according to NEMA BU 1.1, "General Instructions for Proper Handling, Installation, Operation and Maintenance of Busway Rated 600 Volts or Less."
- B. Store products indoors in a clean, dry space having a uniform temperature to prevent condensation (including outdoor busway, which is not weatherproof until completely and properly installed). Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle products carefully to avoid damage to internal components, enclosure, and finish.

1.10 PROJECT CONDITIONS

- A. Derate enclosed bus assemblies for continuous operation at indicated ampere ratings for ambient temperature not exceeding 122 deg F (50 deg C).

1.11 COORDINATION

- A. Coordinate the arrangement of busway with structural members, ductwork, piping, equipment and other potential conflicts.
- B. Coordinate layout and installation of enclosed bus assemblies and suspension system with other construction that penetrates ceilings or floors or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- C. Coordinate size and location of concrete curbs around openings for vertical bus. Concrete, reinforcement, and formwork requirements are specified with concrete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; Schneider Electric
2. Eaton Electrical Inc.; Cutler-Hammer Products.
3. General Electric Company; Electrical Distribution & Control Division.

2.2 ENCLOSED BUS ASSEMBLIES

- A. Feeder-Bus Assemblies: NEMA BU 1, low-impedance bus assemblies in nonventilated housing; single-bolt joints; ratings as indicated.
1. Seismic Fabrication Requirements: Fabricate mounting provisions and attachments for feeder-bus assemblies with reinforcement strong enough to withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems" when mounting provisions and attachments are anchored to building structure.
 2. Voltage: 120/208 and 277/480 V; 3 phase; 100 percent neutral capacity.
 3. Ampere Rating: As indicated on the drawings copper only.
 4. Short circuit rating: Copper busway shall have a minimum of 3-cycle short-circuit rating of 22 kA RMS symmetrical for 225 Ampere ratings, 35 kA RMS symmetrical for 400 Ampere ratings, 65 kA RMS symmetrical for 500 and higher Ampere ratings. Rating shall not be less than the available fault indicated on the drawing or calculated by the Short circuit study.
 5. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.
 6. Bus Materials: Bus bars shall be fabricated from high strength 98% conductivity copper. Current-carrying copper conductors, fully insulated with Class 130C insulation except at joints; silver plated surface at joints. The busway conductors shall be totally enclosed within the housing and shall not require any optional covers to prohibit access to the conductors.
 7. The busway shall consist of standard 10- foot sections with special sections and fittings provided to suit the installation through existing openings in the building unless otherwise specified.
 8. Insulation: Bus bars shall be insulated over their entire length, except at joints and contact surfaces, with a UL listed insulating material consisting of a thermo set epoxy applied by fluidized bed process. Tape or heat-shrink sleeve insulation, or any other method of insulation, which can allow air-gaps or insulation breakdown, shall not be acceptable.
 9. Ground:
 - a. 50 percent capacity internal bus bars of material matching bus material.
 10. Enclosure: Weatherproof, steel or aluminum with manufacturer's standard finish, sealed seams, drains, and removable closures.
 11. Fittings and Accessories: Manufacturer's standard.
 12. Mounting: Arranged flat, edgewise, or vertically without derating.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Support bus assemblies independent of supports for other elements such as equipment enclosures at connections to panelboards and switchboards, pipes, conduits, ceilings, and ducts.
1. Design each fastener and support to carry load indicated by seismic requirements and to comply with seismic-restraint details."
 2. Design each fastener and support to carry 200 lb (90 kg) or 4 times the weight of bus assembly, whichever is greater.
 3. Support bus assembly to prevent twisting from eccentric loading.
 4. Support bus assembly with not less than 3/8-inch (10-mm) steel rods. Install side bracing to prevent swaying or movement of bus assembly. Modify supports after completion to eliminate strains and stresses on bus bars and housings.
 5. Fasten supports securely to building structure according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
- B. Install expansion fittings at locations where bus assemblies cross building expansion joints. Install at other locations so distance between expansion fittings does not exceed manufacturer's recommended distance between fittings.



- C. Construct factory provided rated fire-stop assemblies where bus assemblies penetrate fire-rated elements such as walls, floors, and ceilings.
- D. Provide internal smoke/gas barriers to seal the internal continuous air space in order to prevent the flow of smoke/gasses in the event of a fire in the area of busway installation.
- E. Install weatherseal fittings and flanges where bus assemblies penetrate exterior elements such as walls or roofs. Seal around openings to make weathertight. Coordinate floor penetrations with Structural Drawings.
- F. Install a concrete curb at least 4 inches (100 mm) high around bus-assembly floor penetrations.
- G. Coordinate bus-assembly terminations to equipment enclosures to ensure proper phasing, connection, and closure.
- H. Tighten bus-assembly joints with torque wrench or similar tool recommended by bus-assembly manufacturer. Tighten joints again after bus assemblies have been energized for 30 days.
- I. Install bus-assembly, plug-in units. Support connecting conduit independent of plug-in unit.

3.2 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports. For additional information see section 26 01 26 "Electrical Acceptance Testing".
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- E. Remove and replace units that do not pass tests and inspections and retest as specified above.
- F. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of bus assembly including joints and plug-in units.
 - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Perform 2 follow-up infrared scans of bus assembly, one at 4 months and the other at 11 months after Substantial Completion.
 - 3. Prepare a certified report identifying bus assembly checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.4 ADJUSTING

- A. Set field-adjustable, circuit-breaker trip ranges and overload relay trip settings as indicated.

3.5 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.



3.6 PROTECTION

- A. Provide final protection to ensure that moisture does not enter bus assembly.

END OF SECTION 26 25 00

**SECTION 26 27 13
ELECTRICITY METERING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes equipment for [electricity metering by utility company] [and] [electricity metering by University].

1.3 DEFINITIONS

- A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.
- B. PC: Personal computer.

1.4 ACTION SUBMITTALS

- A. Product Data: Manufacturer's technical data for each type of product indicated.
- B. Shop Drawings: For electricity-metering equipment.
 - 1. Dimensioned plans and sections or elevation layouts.
 - 2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.
- C. Manufacturer Seismic Qualification Certification for Electricity-Metering Equipment: Submit certification that equipment components and their mounting and anchorage provisions have been designed to remain in place without separation of any parts or loosening of factory-made connections when subjected to the seismic forces and shall include the following:
 - 1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculations.
 - 2. Detailed description of equipment mounting and anchorage devices on which the certification is based and their installation requirements.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data. include the following:
 - 1. Application and operating software documentation.
 - 2. Software licenses.
 - 3. Software service agreement.
 - 4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, and marked for intended location and application.
- B. Owner's Meters in switchgear/switchboard/distribution board shall be installed by the manufacturer at the factory.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Receive, store, and handle modular meter center according to NECA 400.



1.9 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted in writing under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify University no fewer than fourteen (14) days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without University's written permission.
 - 3. Comply with NFPA 70E.
 - 4. Provide temporary standby power through a standby diesel quiet type back-up generator complete with fuel and 7/24 monitoring if the existing service interruption exceeds 2 hours. Coordinate additional requirements with owner minimum fourteen days in advance. Indicate method of providing temporary electric service.

1.10 COORDINATION

- A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:
 - 1. Comply with requirements of utilities providing electrical power services.
 - 2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

1.11 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for [two] years from the date of acceptance of the project by the owner.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within [two] <Insert number> years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software at no additional cost to the owner.
 - 1. Provide [30] days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

- A. Meters will be furnished by utility company.
- B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.
- C. Meter Sockets: Comply with requirements of electrical-power utility company.
- D. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.
- E. Modular Meter Center: Factory-coordinated assembly of a main service disconnect device, wireways, tenant meter socket modules, and tenant feeder circuit breakers arranged in adjacent vertical sections. Assembly shall be complete with interconnecting buses and other features as specified below.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - a. Square D; a brand of Schneider Electric
 - b. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - c. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - d. Siemens Energy & Automation, Inc..
 - e. Electrotech
 - 2. Comply with requirements of utility company for meter center.
 - 3. Housing: NEMA 250, [Type 1] [Type 3R] enclosure.
 - 4. Minimum Short-Circuit Rating: [65,000] A symmetrical at rated voltage.
 - 5. Main Disconnect Device: Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers.
 - 6. Main Disconnect Device: Fusible switch, series-combination rated by circuit-breaker manufacturer to protect downstream feeder and branch circuit breakers.



7. Tenant Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect circuit breakers in downstream tenant and to house loadcenters and panelboards that have 10,000-A interrupting capacity.
 - a. Identification: Complying with requirements in Section 260553 "Identification for Electrical Systems" with legend identifying tenant's address.
 - b. Physical Protection: Tamper resistant, with hasp for padlock.
8. Meter Socket: Rating coordinated with indicated tenant feeder circuit rating.
9. Surge Protection: For main disconnect device, comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

2.2 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the
 1. Square D; a brand of Schneider Electric
 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit
 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution
 4. Electrotech
- B. **Provide energy meter for monitoring lighting loads, power loads and mechanical equipment loads in all buildings. Metering shall also be provided for larger equipments consistent with current California energy code and title 24 requirements.**
- C. General Requirements for Owner's Meters:
 1. Comply with UL 1244.
 2. Meters used for billing shall have an accuracy of [0.2] [0.5] [1.0] percent of reading, complying with requirements in ANSI C12.20.
 3. Meters shall be certified by [California Type Evaluation Program] as complying with [Title 4, California Code of Regulations, Article 2.2]
 4. Enclosure: NEMA 250, [Type 1] [Type 3R] [4X Stainless Steel] minimum, with hasp for padlocking or sealing.
 5. Meters installed outdoor shall be in NEMA 4X stainless steel enclosure. Meter in enclosure shall be factory installed and assembled with strip heaters controlled by thermostat.
 6. Identification: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."
 7. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
 8. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
 - a. Type: [Split] [and] [solid] core.
 9. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
 10. Building Automation System (BAS) Interface: One digital KY pulse to a user-definable increment of energy measurement. Match signal to **BAS** input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.
- D. Kilowatt-hour Meter: Electronic three-phase meters, measuring electricity used.
 1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
 2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours and current kilowatt load. Retain accumulated kilowatt-hour in a nonvolatile memory, until reset.
 3. Display: Digital electromechanical counter, indicating accumulative kilowatt-hours.
- E. Kilowatt-hour/Demand Meter: Electronic [single] [three] [single- and three]-phase meters, measuring electricity use and demand. Demand shall be integrated over a [15-minute] <Insert value> interval.
 1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.



2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours, [**current time and date**,]current demand,[**and**] historic peak demand[, **and time and date of historic peak demand**]. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset.
- F. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway. Comply with Section 26 05 23 "Control-Voltage Electrical Power Cables."
- G. Software: PC based, a product of meter manufacturer, suitable for calculation of utility cost allocation and billing.
 1. Utility Cost Allocation: Automatically import energy-usage records to allocate energy costs
 2. Tenant or Activity Billing Software: Automatically import energy-usage records to automatically compute and prepare [**tenant bills**] [**activity demand and energy-use statements**] based on metering of energy use[**and peak demand**]. Maintain separate directory for each tenant's historical billing information. Prepare summary reports in user-defined formats and time intervals.
 3. Accessories:
 - a. Fuses: Provide fuses to protect meters.
 - b. Shunting Devices: Provide shunting devices for maintenance of meters.
- H. Accessories:
 1. Fuses: Provide fuses to protect meters.
 2. Shunting Devices: Provide shunting devices for maintenance of meters.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.
- B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
- C. Install modular meter center according to NECA 400 switchboard installation requirements.

3.2 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
 1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
 2. Equipment Identification Labels: Adhesive film labels with clear protective overlay. For residential meters, provide an additional card holder suitable for printed, weather-resistant card with occupant's name.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
 2. Turn off circuits supplied by metered feeder and secure them in off condition.
 3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
 4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results. This shall be done in the presence of Owner's Meter Shop Personnel. Coordinate through Owner's Representative.
- C. Electricity metering will be considered defective if it does not pass tests and inspections.



D. Prepare test and inspection reports.

END OF SECTION 26 27 13

**SECTION 26 27 26
WIRING DEVICES**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Weather-resistant receptacles.
 - 3. Snap switches
 - 4. Wall-switch
 - 5. Wall Plates.
 - 6. Finishes
 - 7. Indoor ceiling mounted occ. Sensor
 - 8. Wall Box mounted occ. Sensor

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - 2. Hubbell Incorporated; Wiring Device-Kellems.
 - 3. Leviton Manufacturing Co., Inc.
 - 4. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).

2.4 GFCI RECEPTACLES

- A. General Description:
 - 1. Straight blade, feed-through type.
 - 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).

2.5 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Single Pole:
 - 1) Cooper; AH1221.
 - 2) Hubbell; HBL1221.
 - 3) Leviton; 1221-2.
 - 4) Pass & Seymour; CSB20AC1.
 - b. Three Way:
 - 1) Cooper; AH1223.
 - 2) Hubbell; HBL1223.
 - 3) Leviton; 1223-2.
 - 4) Pass & Seymour; CSB20AC3.

2.6 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. All plates shall be of stainless steel construction.
 - 2. Plate-Securing Screws: Metal with head color to match plate finish.
 - 3. Material for Finished Spaces: 0.035-inch- thick, satin-finished, Type 302 stainless steel.
 - 4. Material for Unfinished Spaces: Galvanized steel.
 - 5. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.



- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.7 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: Stainless Steel unless otherwise indicated or required by NFPA 70 or device listing.

2.8 INDOOR CEILING MOUNTED OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide **nLight Control System Acuity brand**
- B. General Requirements for Sensors: Ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 - 4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - 5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 - 7. Bypass Switch: Override the "on" function in case of sensor failure.
 - 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
 - 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

2.9 SWITCHBOX MOUNTED OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide **nLight Control System Acuity brand**
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application, **and shall comply with California Title 24.**
 - 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 - 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

- C. Wall-Switch Sensor:
1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of **900 sq. ft.**
 2. Sensing Technology: Dual technology - PIR and ultrasonic.
 3. Switch Type: SP, manual "on," automatic "off."
 4. Voltage: Match the circuit voltage
 5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
 8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 8. Tighten unused terminal screws on the device.
 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.



10. All receptacles and switches installed in restroom shall be installed in an easily accessible space. Each device location in restroom shall be coordinated with College facility prior to setting up of boxes. Install GFCI Service Receptacle in each restroom.
- E. Receptacle Orientation:
 1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 IDENTIFICATION

- A. Comply with Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each receptacle, switch and power devices with panelboard identification, circuit number and room number. Use engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
- C. Identify each sensor and switch with panelboard identification, circuit number, room number and lighting controller name and location of lighting controller. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Test Instruments: Use instruments that comply with UL 1436.
 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Convenience Receptacles:
 1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 26 27 26

**SECTION 26 28 13
FUSES**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cartridge fuses rated 600-V ac and less for use in [control circuits] [enclosed switches] [panelboards] [switchboards] [enclosed controllers] [and] [motor-control centers].
 - 2. Plug fuses rated 125-V ac and less for use in plug-fuse-type [enclosed switches] [fuseholders] [and] [panelboards].
 - 3. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
 - 4. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.[Submit on translucent log-log graph paper.]
 - 5. Coordination charts and tables and related data.
 - 6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. include the following:
 - 1. Ambient temperature adjustment information.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.
 - 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.[Submit on translucent log-log graph paper.]
 - 4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to [10] percent of quantity installed for each size and type, but no fewer than [two] of each size and type.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.



- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

1.7 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than [40 deg F (5 deg C)] or more than [100 deg F (38 deg C)].

1.8 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 1. Cooper Bussmann, Inc.
 2. Edison Fuse, Inc.
 3. Ferraz Shawmut, Inc.
 4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 PLUG FUSES

- A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

2.4 PLUG-FUSE ADAPTERS

- A. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuseholders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

2.5 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 1. Size: Adequate for storage of spare fuses specified with **15** percent spare capacity minimum.
 2. Finish: Gray, baked enamel.
 3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.



3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Service Entrance: **[Class L, fast acting]** **[Class L, time delay]** **[Class RK1, fast acting]** **[Class RK1, time delay]** **[Class J, fast acting]** **[Class J, time delay]** **[Class T, fast acting]**.
 - 2. Feeders: **[Class L, fast acting]** **[Class L, time delay]** **[Class RK1, fast acting]** **[Class RK1, time delay]** **[Class RK5, fast acting]** **[Class RK5, time delay]** **[Class J, fast acting]** **[Class J, time delay]**.
 - 3. Motor Branch Circuits: **[Class RK1]** **[Class RK5]**, time delay.
 - 4. Other Branch Circuits: **[Class RK1, time delay]** **[Class RK5, time delay]** **[Class J, fast acting]** **[Class J, time delay]**.
 - 5. Control Circuits: Class CC, **[fast acting]** **[time delay]**.
- B. Plug Fuses:
 - 1. Motor Branch Circuits: **[Edison-base type, dual]** **[Edison-base type, single]** **[Type S, dual]** **[Type S, single]**-element time delay.
 - 2. Other Branch Circuits: **[Edison-base type, single-element fast acting]** **[Edison-base type, dual-element time delay]** **[Edison-base type, single-element time delay]** **[Type S, dual-element time delay]** **[Type S, single-element time delay]**.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.
- C. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13



SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Receptacle switches.
 - 4. Shunt trip switches.
 - 5. Molded-case circuit breakers (MCCBs).
 - 6. Molded-case switches.
 - 7. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.



3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Manufacturer's field service report.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 13 "Operation and Maintenance Data," include the following:
 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member Company of NETA or an NRTL.
 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NFPA 70.

1.9 PROJECT CONDITIONS

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 1. Notify Construction Manager and College no fewer than 14 days in advance of proposed interruption of electric service.
 2. Notify Construction Manager and College no fewer than 30 days in advance of proposed interruption of electric service that require shut downs that last multiple days, and require shut down of buildings other than the Chiller Plant.
 3. Do not proceed with interruption of electric service without Construction Manager's and College's written permission.
 4. Comply with NFPA 70E.

1.10 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.



PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. General Electric Company.
 - 2. Siemens Industry, Inc.
 - 3. Square D.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 5. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 6. Service-Rated Switches: Labeled for use as service equipment.
 - 7. Auxiliary Contacts: Where indicated on the drawings to interlock with VFD control circuit, furnish one normally open and normally closed contact(s) that operate with switch handle operation.

2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. General Electric Company.
 - 2. Siemens Industry, Inc.
 - 3. Square D.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 4. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 5. Auxiliary Contacts: Where indicated on the drawings to interlock with VFD control circuit, furnish one normally open and normally closed contact(s) that operate with switch handle operation.

2.3 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Section 26 05 48 Electrical System Vibration Isolation and Seismic Restraints.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- E. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.



- G. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 26 28 16

**SECTION 26 31 00
PHOTOVOLTAIC COLLECTORS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. PV system description.
 - 2. Manufactured PV units.
 - 3. PV module framing.
 - 4. PV array construction.
 - 5. Inverters.
 - 6. System overcurrent protection.
 - 7. Mounting structures.

1.3 DEFINITIONS

- A. CEC: California Energy Commission.
- B. ETFE: Ethylene tetrafluoroethylene.
- C. FEP: Fluorinated ethylene propylene.
- D. IP Code: Required ingress protection to comply with IEC 60529.
- E. MPPT: Maximum power point tracking.
- F. PTC: PVUSA Test Condition. Commonly regarded as a "real-world" measure of PV output. See below for definition of "PVUSA."
- G. PV: Photovoltaic.
- H. PVUSA: Photovoltaics for Utility Systems Applications.
- I. STC: Standard Test Conditions defined in IEC 61215.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for PV panels.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For PV modules.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Detail fabrication and assembly.
 - 4. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special materials and workmanship warranty and minimum power output warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For PV modules to include in operation and maintenance manuals.



1.7 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of PV modules that fail in materials or workmanship within specified warranty period.
 - 1. Manufacturer's materials and workmanship warranties include, but are not limited to, the following:
 - a. Faulty operation of PV modules.
 - 2. Warranty Period: **[Five]** years from date of Substantial Completion.
- B. Manufacturer's Special Minimum Power Output Warranty: Manufacturer agrees to repair or replace components of PV modules that fail to exhibit the minimum power output within specified warranty period. Special warranty, applying to modules only, applies to materials only, on a prorated basis, for period specified.
 - 1. Manufacturer's minimum power output warranties include, but are not limited to, the following warranty periods, from date of Substantial Completion:
 - a. Specified minimum power output to **[80]** percent or more, for a period of **[25]** years.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Optimus Monocrystalline Series by Suniva to match existing campus standard unless otherwise mentioned on the drawings

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Hazardous Locations: FM Global approved for NFPA 70, Class 1, Division 2, Group C and Group D.
- C. Seismic Qualification Certificates: For **equipment**, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

2.3 PV CAPACITIES AND CHARACTERISTICS

- A. Minimum Electrical Characteristics:
 - 1. Rated Open-Circuit Voltage: **38-40 V dc**.
 - 2. Maximum System Voltage: **1000 V dc**.
 - 3. Maximum Power at Voltage (Vpm): **275-290V dc**.
 - 4. Rated Short-Circuit Current (Isc): **9-10A**.

2.4 PV SYSTEMS DESCRIPTION

- A. Interactive PV System: Collectors connected in parallel to the electrical utility; and capable of providing power for Project and supplying power to a distributed network.
 - 1. Refer to drawings for the number of module and equivalent power generation.>.
 - 2. System Components:
 - a. PV modules.
 - b. Array frame.
 - c. Utility-interactive inverter.
 - d. Overcurrent protection, disconnect, and rapid shutdown devices.
 - e. Mounting structure.
 - f. Utility meter.
- B. Stand-Alone PV System: Collectors connected to provide power to Project dc and ac loads through an energy storage system.

1. Refer to drawings for the number of module and equivalent power generation
2. System Components:
 - a. PV modules.
 - b. Array frame.
 - c. Charge controller.
 - d. Energy storage.
 - e. Inverter.
 - f. Overcurrent protection, disconnect, and rapid shutdown devices.
 - g. Mounting structure.

2.5 MANUFACTURED PV UNITS

- A. Cell Materials: **Monocrystalline**.
 1. c-Si.
 2. Gallium arsenide (GaAs).
- B. Module Construction:
 1. Nominal Size: 39 inches wide by 66 inches long.
 2. Weight: 42.8 lb.
- C. Encapsulant: Ethyl vinyl acetate.
- D. Front Panel: Fully tempered glass. Antireflective coating glass.
- E. Backing Material: Tempered glass.

2.6 PV MODULE FRAMING

- A. PV laminates mounted in anodized extruded-aluminum frames.
 1. Entire assembly UL listed for electrical and fire safety, **[Class A] [Class C]**, according to UL 1703, and complying with IEC 61215.
 2. Frame strength exceeding requirements of certifying agencies in subparagraph above.
 3. Finish: Anodized aluminum.
 - a. Alloy and temper recommended by framing manufacturer for strength, corrosion resistance, and application of required finish.
 - b. Color: As indicated by manufacturer's designations.

2.7 PV ARRAY CONSTRUCTION

- A. Framing:
 1. Material: **[Extruded aluminum]**
 2. Maximum System Weight: Less than 4 lb/sq. ft..
 3. Minimum Distance to Connectors: **<Insert inches>**.
 4. Raceway Cover Plates: **[Plastic] [Aluminum] [Galvanized steel]**.
- B. Flat-Roof Mounting:
 1. No roof penetrations.
 2. Self-ballasting.
 3. Wind-tunnel tested to 110-mph wind.
 4. Service Life: **[25]** years.
 5. Freestanding system.

2.8 INVERTER

- A. Inverter Type: **Microinverter M215 by Enphase to match existing campus standard unless otherwise mentioned on the drawings.**
- B. Control Type: Pulse-width-modulation control.
- C. Control Type: Maximum power point tracker control.
- D. Inverter Electrical Characteristics:
 1. Maximum Recommended PV Input Power: **350 Watt.**



2. Maximum input DC voltage 60 V
 3. Peak power tracking voltage 27 V - 48 V
 4. Operating range 16 V - 60 V
 5. Min/Max start voltage 22 V / 60 V
 6. Max DC short circuit current 15 A
 7. CEC weighted efficiency 96.5%
 8. Peak inverter efficiency 96.5%
 9. Night time power consumption 76 mW nominal
 10. Compatibility Compatible with 60- and 72-cell PV modules
 11. Communication: Power line
- E. Operating Conditions:
1. Operating Ambient Temperatures: Minus 4 to plus 122 deg F.
 2. Storage Temperature: Minus 40 to plus 122 deg F.
 3. Relative Humidity: Zero to 95 percent, noncondensing.
- F. Charge controllers shall have the following:
1. Overcurrent protection.
 2. Generator input breaker box.
 3. Automatic transfer relay.
 4. Digital display.
 5. Transformer.
 6. Disconnect switch.
 7. Shunt controller.
 8. Shunt regulator.
 9. Surge overload protection.
- G. Enclosure:
1. NEMA 250 **[Type 6]**.
 2. Enclosure Material: **[Galvanized steel]**.
 3. Cooling Methods:
 - a. Passive cooling.
 4. Protective Functions:
 - a. AC over/undervoltage.
 - b. AC over/underfrequency.
 - c. Ground overcurrent.
 - d. Overtemperature.
 - e. AC and dc overcurrent.
 - f. DC overvoltage.
 5. Standard LCD, four lines, 20 characters, with user display and on/off toggle switch.
- H. Disconnects: Rated for system voltage and conductor.
- I. Regulatory Approvals:
1. IEEE 1547.1.
 2. IEEE 1547.3.
 3. UL 1741.

2.9 SYSTEM OVERCURRENT PROTECTION

- A. Fuses: <Refer to drawings for fuse size indicated.>.
- B. Circuit Breakers: <refer to drawing for circuit breaker size indicated.>.

2.10 MOUNTING STRUCTURES

- A. Roof Mount: Extruded aluminum, **[two]** **[four]** rails, tilt legs, and roof standoffs.
- B. Pole Mount: **[Top]** **[Panel tops]** **[Side]**.

- C. Tracking Mounts: **[One]** **[Two]** axis.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrate areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Do not begin installation until mounting surfaces have been properly prepared.
- C. If preparation of mounting surfaces is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- D. Examine modules and array frame before installation. Reject modules and arrays that are wet, moisture damaged, or mold damaged.
- E. Examine roofs, supports, and supporting structures for suitable conditions where PV system will be installed.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of PV panels with **[roof]** **[support]** assembly and other construction.
- C. Support PV panel assemblies independent of supports for other elements such as roof and support assemblies, enclosures, vents, pipes, and conduits. Support assembly to prevent twisting from eccentric loading.
- D. Install PV **inverters, energy storage, charge controller, rapid shutdown, and system control** in locations indicated on Drawings.
- E. Install weatherseal fittings and flanges where PV panel assemblies penetrate exterior elements such as walls or roofs. Seal around openings to make weathertight. See Section 079200 "Joint Sealants" for materials and application.
- F. Seismic Restraints: Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electric Systems."
- G. Wiring Method: Install cables in raceways.
- H. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 CONNECTIONS

- A. Coordinate PV panel cabling to equipment enclosures to ensure proper connections.
- B. Coordinate installation of utility-interactive meter with utility.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

END OF SECTION 26 31 00



**SECTION 26 32 13
ENGINE GENERATORS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes packaged engine-generator sets for [emergency] [standby] power supply with the following features:
 - 1. [Gas] [Diesel] engine.
 - 2. Generators
 - 3. [Unit-mounted] [Remote-mounting] cooling system.
 - 4. [Unit-mounted] [Remote-mounting] control and monitoring.
 - 5. Performance requirements for sensitive loads.
 - 6. Load banks.
 - 7. Outdoor enclosure.
 - 8. Battery charger.
 - 9. Day tank.
 - 10. Muffler.
 - 11. Exhaust piping external to set.
 - 12. Remote annunciator.
 - 13. Remote radiator.
 - 14. Remote stop switch.
 - 15. Starting battery.
- B. Related Sections include the following:
 - 1. Section 23 21 13 "Hydronic Piping.
 - 2. Section 26 05 48 "Vibrations and Seismic Controls"
 - 3. Section 26 05 26 "Grounding and Bonding for Electrical Systems."
 - 4. Section 26 24 16 "Panelboards"
 - 5. Section 26 28 16 Enclosed Switches and Circuit Breakers.
 - 6. Section 26 36 00 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- B. LP: Liquid petroleum.
- C. NETA: InterNational Electrical Testing Association
- D. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

1.4 STANDARDS

- A. National Electrical Manufacturer's Association (NEMA).
- B. National Fire Protection Association (NFPA).
- C. California Electric Code (CEC).
- D. California Air Resource Board (CARB).
- E. County of San Diego Air Pollution Control District (SDAPCD).
- F. South Coast Air Quality Management District (SCAQMD)

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
 - 1. Thermal damage curve for generator.
 - 2. Time-current characteristic curves for generator protective device.
 - 3. Technical data sheets of each equipment.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 - 2. Brake horsepower of engine.
 - 3. Fuel consumption and floor plans showing fuel line connections, pipe sizes and pump requirements.
 - 4. Cooling air requirements and its design.
 - 5. Noise db level.
 - 6. Electrical characteristics of generator, voltage regulator, and battery charger.
 - 7. Load graphs and load calculations to show the capabilities to supply the largest motor while connected to the full load. It shall also indicate the sequencing of the emergency load start-up.
 - 8. Control panel.
 - 9. Elevations of equipment including front elevation, side elevation, top view for complete assembly.
 - 10. Engine and generator details, including governor, turbocharger, exciter, after/intercooler, day tank, main fuel storage tank and associated required pumping drawings. The work shall indicate the method of the installation of the electrical, mechanical and plumbing work.
 - 11. Certified independent test lab data of generator characteristics, verification of emissions conformance to latest applicable regulations of CARB and AQMD [or APCD].
 - 12. Main line circuit breaker.
 - 13. List showing manufacturer of each major component.
 - 14. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 15. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
 - 16. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer installed and field installed wiring.
 - 17. Indicate name and place of manufacture of each major component.

1.6 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that [**day tank**,]engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Manufacturer's dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Coordination Drawings: Floor plans, drawn to scale (1/4"=1'-0"), showing dimensioned layout, required working clearances, and required area above and around Engine Generator set where pipe and ducts are prohibited. Show Engine Generator layout and relationships between electrical components and



adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

- C. Manufacturer's certified letter stating that unit complies with all California State Codes, Uniform Building Code (UBC), California Air Resource Board (CARB), California Electrical Code (CEC), latest edition and supplements and National Electric Manufacturer's Association (NEMA) standards for an emergency power plant.
- D. Sound levels shall be measured in the octave bands, having center frequencies from 31.5 Hz to 8000 Hz according to the procedures given in American National Standards Institute (ANSI) Standards SI.13.71. Measurements shall be made in at least four locations as described in the standard and shall be made at a distance of one meter from the surface of the equipment. Sound levels generated shall be within acceptable limits.
- E. Qualification Data: For [installer] [manufacturer] [and] [testing agency].
- F. Source quality-control test reports.
 - 1. Certified summary of prototype-unit test report.
 - 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
 - 3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
 - 4. Certified Test Report of factory tests on units to be shipped for this Project, showing evidence of compliance with specified requirements. Submit within two (2) weeks of completion of tests. Report shall be signed by a factory testing engineer.
 - 5. Report of sound generation.
 - 6. Report of exhaust emissions showing compliance with applicable regulations.
- G. Field quality-control test reports.
- H. Warranty: Special warranty specified in this Section.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. include the following:
 - 1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply (address and phone number of sources).

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
 - 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

1.9 QUALITY ASSURANCE

- A. American made products have been acceptable to the Owner. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the Owner and all tests shall be witnessed by Owner's personnel. Testing procedures and test results shall be satisfactory to the Owner. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one Owner's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within **75 miles** of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.



- C. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of Emergency/Standby Engine Generators similar to the type and size specified in this project. Furnish a list of three (3) contacts for the three (3) similar projects completed within the last 5 years. Include name, tele no and email of the facility engineers.
- D. Manufacturer shall have ISO 9001 or 9002 Certification.
- E. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer confirming the availability.
- F. Engine Generators shall be assembled at the manufacturer's own manufacturing facility using its own major devices (e.g., circuit breakers) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- G. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Major components (e.g. engines, generators, governors, controls) shall be manufactured within six months of installation.
- H. Source Limitations: Obtain packaged engine generators, and accessories through one source from a single manufacturer through a local distributor. Manufacturer of overcurrent devices shall match other power distribution equipment on the project.
- I. Comply with ASME B15.1.
- J. Comply with NFPA 37.
- K. Comply with NFPA 70.
- L. Comply with NFPA 110 requirements for Level [1] [2] emergency power supply system.
- M. Comply with UL 2200.
- N. Engine Exhaust Emissions: Comply with applicable state and local government requirements. Engine Exhaust Emissions: Apply and obtain a permit to construct and a permit to operate from Air Pollution Control District (authority having jurisdiction of the project) including payment of permit fees and health risk assessment fees. Contractor shall submit complete emission data along with the shop drawings for the generator set within six (6) weeks of receiving Notice to Proceed. Contractor shall not start installation without proper permits from the authority having jurisdiction.
- O. Noise Emission: Comply with **applicable state and local government requirements** for maximum noise level due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
- P. Product Options: Drawings indicate size, profiles, and dimensional requirements of engine generators and are based on the specific system indicated
- Q. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100, and marked for intended location and application.
- R. Testing Agency Qualifications: Member of NETA;
 - 1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of ten (10) years and has permanent in-house testing engineers and technicians involved with testing of switchboards, panelboards and OCPDs similar to those specified on this project.
 - 2. Testing company shall be located with 50 miles radius of the project.
 - 3. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
- S. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
 - 1. Maintenance Proximity: Not more than [four] hours' normal travel time from Installer's place of business to Project site.



2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

1.10 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 1. Notify [**Architect**] [**Construction Manager**] [**Owner**] no fewer than [**fourteen (14)**] <Insert number> days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without [**Architect's**] [**Construction Manager's**] [**Owner's**] written permission.
- B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 1. Ambient Temperature: **5 to 40 deg C.**
 2. Relative Humidity: 0 to 95 percent.
 3. Altitude: Sea level to **1000 feet**

1.11 COORDINATION

- A. Coordinate size and location of concrete bases for package engine generators[**and remote radiators mounted on grade**]. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators. These items are specified in Section 07 72 00 "Roof Accessories."

1.12 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: **Five** years from date of Substantial Completion.

1.13 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide **24** months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Caterpillar; Engine Div.
 2. Onan/Cummins Power Generation; Industrial Business Group
 3. Kohler Co.; Generator Division.
 4. Or Equal.

2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- C. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated[, with capacity as required to operate as a unit as evidenced by records of prototype testing].
 2. Output Connections: Three-phase, [**three**] [**four**] wire or Single phase three wire. Refer to drawings for more information.
 3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- D. Generator-Set Performance:
1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
 3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
 6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
 7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
 8. Start Time: Comply with NFPA 110, Type 10, system requirements.
- E. Generator-Set Performance for Sensitive Loads:
1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
 - a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
 2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
 3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
 4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
 5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
 7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
 8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
 - a. Provide permanent magnet excitation for power source to voltage regulator.
10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

- A. Fuel: Diesel
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.
- D. Lubrication System: The following items are mounted on engine or skid:
 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Engine Fuel System:
 1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
 2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
 3. Dual Natural Gas with LP-Gas Backup (Vapor-Withdrawal) System:
 - a. Carburetor.
 - b. Secondary Gas Regulators: One for each fuel type.
 - c. Fuel-Shutoff Solenoid Valves: One for each fuel source.
 - d. Flexible Fuel Connectors: One for each fuel source.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
- G. Governor: **[Mechanical] [Adjustable isochronous, with speed sensing]**.
- H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- I. Cooling System: Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump.
 1. Configuration: **[Vertical] [Horizontal]** air discharge.
 2. Radiator Core Tubes: **[Aluminum] [Nonferrous-metal construction other than aluminum]**.
 3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 5. Fan: Driven by [multiple belts from engine shaft] [totally enclosed electric motor with sealed bearings].
 6. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- J. Muffler/Silencer: Critical type, super quiet, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. **Provide stainless steel type muffler including pipe connection to engine where these are exposed to weather..**
1. Minimum sound attenuation of 25 dB at 500 Hz.
 2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be **[85] <Insert number>** dBA or less.
- K. Air-Intake Filter: **Heavy-duty**, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator. Provide new filters after completion for field tests and before acceptance by the owner.
- L. Starting System: **[12] [24]**-V electric, with negative ground.
1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 3. Cranking Cycle: **[As required by NFPA 110 for system level specified]**.
 4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least **[three times]** without recharging.
 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 6. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 7. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
 - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
 - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

- A. Comply with NFPA 30. Fuel system shall be complete and shall consist of a dual filtering system, fuel storage tank, day tank and engine fuel pump. Provide fuel for testing and full tank after testing.



- B. Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
 - 1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.
 - a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak. Alarm shall be remotely monitored by BMS system.
 - 2. Tank Capacity: [As recommended by engine manufacturer for an uninterrupted period of [24] hours' operation at 100 percent of rated power output of engine-generator system without being refilled.
 - 3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
 - 4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
 - 5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
 - 6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
 - 7. Generator shall be equipped with a fuel polishing system.
- C. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
 - 1. Tank level indicator.
 - 2. Capacity: Fuel for [24] hours' continuous operation at 100 percent rated power output.
 - 3. Vandal-resistant fill cap.
 - 4. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.5 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel.
 - 1. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
 - 2. Switchboard Construction: Freestanding unit complying with Section 26 24 13 "Switchboards."
 - 3. Switchgear Construction: Freestanding unit complying with Section 26 23 00 "Low-Voltage Switchgear."
 - 4. Current and Potential Transformers: Instrument accuracy class.
- C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level [1] [2] system, and the following:
 - 1. AC voltmeter.
 - 2. AC ammeter.
 - 3. AC frequency meter.
 - 4. DC voltmeter (alternator battery charging).
 - 5. Engine-coolant temperature gage.
 - 6. Engine lubricating-oil pressure gage.
 - 7. Running-time meter.
 - 8. Ammeter-voltmeter, phase-selector switch(es).
 - 9. Generator-voltage adjusting rheostat.
 - 10. Fuel tank derangement alarm.

11. Fuel tank high-level shutdown of fuel supply alarm.
 12. Generator overload.
- D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Section 260913 "Electrical Power Monitoring and Control."
- F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
1. Overcrank shutdown.
 2. Coolant low-temperature alarm.
 3. Control switch not in auto position.
 4. Battery-charger malfunction alarm.
 5. Battery low-voltage alarm.
- G. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
1. Engine high-temperature shutdown.
 2. Lube-oil, low-pressure shutdown.
 3. Overspeed shutdown.
 4. Remote emergency-stop shutdown.
 5. Engine high-temperature prealarm.
 6. Lube-oil, low-pressure prealarm.
 7. Fuel tank, low-fuel level.
 8. Low coolant level.
- H. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
- I. Remote Emergency-Stop Switch: Red mush-room head type with an engraved label "EMERGENNCY STOP SWITCH". Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation with a transparent see-thru lexan cover.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker (**below 400A Frame**): Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.
1. Tripping Characteristic: Designed specifically for generator protection.
 2. Trip Rating: Matched to generator rating.
 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 4. Mounting: Adjacent to or integrated with control and monitoring panel.
 5. Enclosure: Provide NEMA 4X stainless steel enclosure for breakers mounted exposed to weather.
- B. Generator Circuit Breaker (**400A Frame and above**): Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Field adjustable long-time and short-time delay and instantaneous. Trip unit shall be field replaceable.
 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.

4. Mounting: Adjacent to or integrated with control and monitoring panel.
5. Enclosure: Provide NEMA 4X stainless steel enclosure for breakers mounted exposed to weather.
- C. Generator Circuit Breaker (**400A Frame and above**): Insulated-case, electronic-trip type; 100 percent rated; complying with UL 489.
 1. Tripping Characteristics: Field adjustable long-time and short-time delay and instantaneous. Trip unit shall be field replaceable.
 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 4. Mounting: Adjacent to or integrated with control and monitoring panel.
 5. Enclosure: Provide NEMA 4X stainless steel enclosure for breakers mounted exposed to weather.
- D. Generator Disconnect Switch: Molded-case type, 100 percent rated.
 1. Rating: Matched to generator output rating.
 2. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.
 3. Enclosure: Provide NEMA 4X stainless steel enclosure for breakers mounted exposed to weather.
- E. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
 1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
 2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
- F. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications. Alarm shall be remotely monitored by BMS.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Dripproof.
- G. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
 1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- H. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

2.8 LOAD BANK

- A. Description: Permanent, outdoor, weatherproof, remote-controlled, forced-air-cooled, **[resistive]** **[resistive and reactive]** unit capable of providing a balanced 3-phase, delta-connected load to generator set at **[100]** percent rated-system capacity, at **[80]** percent power factor, lagging. Unit may be composed of separate resistive and reactive load banks controlled by a common control panel. Unit shall be capable of selective control of load in 25 percent steps and with minimum step changes of approximately 5 and 10 percent available.
- B. Resistive Load Elements: Corrosion-resistant chromium alloy with ceramic and steel supports. Elements shall be double insulated and designed for repetitive on-off cycling. Elements shall be mounted in removable aluminized-steel heater cases.
- C. Reactive Load Elements: Epoxy-encapsulated reactor coils.
- D. Load-Bank Heat Dissipation: Integral fan with totally enclosed motor shall provide uniform cooling airflow through load elements. Airflow and coil operating current shall be such that, at maximum load, with ambient temperature at the upper end of specified range, load-bank elements operate at not more than 50 percent of maximum continuous temperature rating of resistance elements.
- E. Load Element Switching: Remote-controlled contactors switch groups of load elements. Contactor coils are rated 120 V. Contactors shall be located in a separate NEMA 250, Type 3R enclosure within load-bank enclosure, accessible from exterior through hinged doors with tumbler locks.
- F. Contactor Enclosures: Heated by thermostatically controlled strip heaters to prevent condensation.
- G. Load-Bank Enclosures: NEMA 250, Type 3R, complying with NEMA ICS 6. Finish shall match with finish of the Generator enclosure. Louvers at cooling-air intake and discharge openings shall prevent entry of rain and snow. Openings for airflow shall be screened with 1/2-inch-square, galvanized-steel mesh. Reactive load bank shall include automatic shutters at air intake and discharge.
- H. Protective Devices: Power input circuits to load banks shall be fused, and fuses shall be selected to coordinate with generator circuit breaker. Fuse blocks shall be located in contactor enclosure. Cooling airflow and overtemperature sensors shall automatically shut down and lock out load bank until manually reset. Safety interlocks on access panels and doors shall disconnect load power, control, and heater circuits. Fan motor shall be separately protected by overload and short-circuit devices. Short-circuit devices shall be noninterchangeable fuses with 200,000-A interrupting capacity.
- I. Remote-Control Panel: Separate from load bank in NEMA 250, Type 1 enclosure with a control power switch and pilot light, and switches controlling groups of load elements.
- J. Control Sequence: Control panel may be preset for adjustable single-step loading of generator during automatic exercising.

2.9 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Prefabricated or preengineered walk-in enclosure of sufficient size to allow code required clearances on all sides and maintenance. Provide with the following features:
 - 1. Construction: Galvanized-steel, or **[NEMA 4X stainless steel]** metal-clad, integral structural-steel-framed building erected on concrete foundation. .
 - 2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
 - 3. Enclosure shall have sound attenuation to reduce the noise to 70dB at 21 feet.
 - 4. Space Heater: Thermostatically controlled and sized to prevent condensation.
 - 5. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
 - 6. Hinged Doors: With padlocking provisions.
 - 7. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
 - 8. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.



9. Muffler Location: **[Within]** **[External to]** enclosure. Verify with owner if enclosure walls need to be extended up to hide the external muffler so that it is not visible from grade.
- B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
- C. Lighting panelboard: Provide a 100A, 120/208V single phase 3 W NEMA 1 lighting panel with main circuit breaker inside the walk-in enclosure. Panel shall have bolt-on type main and branch breakers to serve branch circuits for block heaters, battery charger, interior and exterior lights, outlets, cooling fan plus minimum three spare 20A-1 pole breakers.
- D. Interior Lights with Switch: Factory-wired, vaporproof-type fluorescent fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
 1. AC lighting system and connection point for operation when remote source is available.
 2. DC lighting system for operation when remote source and generator are both unavailable.
- E. Convenience Outlets: Specification grade, factory wired, **[GFCI]**. Arrange for external electrical connection.

2.10 MOTORS

- A. General requirements for motors are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

2.11 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
 1. Material: **[Standard neoprene]** **[Natural rubber]** **[Bridge-bearing neoprene, complying with AASHTO M 251]**.
 2. Durometer Rating: **[30]** **[40]** **[45]** **[50]** **[60]** **[65]** **[70]** **<Insert number>**.
 3. Number of Layers: **[One]** **[Two]** **[Three]** **[Four]** **<Insert number>**.
- B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.12 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.13 SOURCE QUALITY CONTROL



- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. One hour at 25 percent load.
 - 2. One hour at 50 percent load.
 - 3. Two hours at 75 percent load.
 - 4. Two hours at 100 percent load.
- C. Test data shall be recorded and included in the maintenance manual. The following test data shall be recorded during factory and field tests:
 - 1. Voltage:
 - a. Strip chart for 15 minutes at 75 percent load.
 - b. Strip chart for 15 minutes at 100 percent load.
 - 2. Current:
 - a. Strip chart for 15 minutes at 75 percent load.
 - b. Strip chart for 15 minutes at 100 percent load.
 - 3. Frequency:
 - a. Strip chart for 15 minutes at 75 percent load.
 - b. Strip chart for 15 minutes at 100 percent load.
 - 4. Oil Pressure: Record in 15-minute intervals during test.
 - 5. Water Temperature: Record in 15-minute intervals during test.
 - 6. Water Pressure: Record in 15-minute intervals during test.
 - 7. Oil Temperature: Record in 15 minute intervals during test.
 - 8. KW Output: Record in 15-minute intervals during test.
 - 9. Test shall include testing with cold start including jacket heaters.
 - 10. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 - 11. Voltage regulation.
 - 12. Transient and steady-state governing.
 - 13. Single-step load pickup.
 - 14. Safety shutdown.
 - 15. Observation of Factory Tests: Provide 14 days' advance notice of tests and opportunity for observation of tests by College's representative.
- D. Report factory test results within 10 days of completion of test.
 - 1. Report shall be reviewed, signed by the factory testing engineer. Include name of the engineer, date and location of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.



- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator with [elastomeric isolator pads] [restrained spring isolators] having a minimum deflection of [1 inch] on 4-inch-high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- D. Install remote radiator with [elastomeric isolator pads] [restrained spring isolators] having a minimum deflection of [1 inch] on [concrete base on grade]
- E. Install Schedule 40, black steel piping with welded joints for cooling water piping between engine-generator set and [heat exchanger] [remote radiator]. Piping materials and installation requirements are specified in Section 23 21 13 "Hydronic Piping."
- F. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Section 23 21 13 "Hydronic Piping."
 - 1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Section 23 21 13 "Hydronic Piping."
- G. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect cooling-system water piping to engine-generator set and [remote radiator] [heat exchanger] with flexible connectors.
- D. Connect engine exhaust pipe to engine with flexible connector.
- E. Install exhaust-system piping. Extend to point of termination outside structure. Size piping according to manufacturer's written instructions.
 - 1. Install condensate drain piping for engine exhaust system. Extend drain piping from low points of exhaust system and from muffler to condensate traps and to point of disposition.
- F. Connect fuel piping to engines with a gate valve and union and flexible connector.
 - 1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Section 23 11 13 "Facility Fuel-Oil Piping."
 - 2. Natural-gas piping, valves, and specialties for gas distribution are specified in Section 23 11 23 "Facility Natural-Gas Piping."
 - 3. LP-gas piping, valves, and specialties for gas piping are specified in Section 23 11 26 "Facility Liquefied-Petroleum Gas Piping."
- G. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- H. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

- A. Identify system components according to Section 23 05 53 "Identification for HVAC Piping and Equipment" and Section 26 05 53 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: [Engage] a qualified testing agency to perform tests and inspections and prepare test reports.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection[**(except those indicated to be optional)**] for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 - 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
 - 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 - 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 - 6. Exhaust Emissions Test: Comply with applicable government test criteria.
 - 7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
 - 8. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
- E. Coordinate tests with tests for transfer switches and run them concurrently.
- F. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- G. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- H. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- I. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- J. Remove and replace malfunctioning units and [**retest**] as specified above.
- K. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- L. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.



- M. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Training shall be held on site after the generator set is complete and fully functional.

END OF SECTION 26 32 13



**SECTION 26 33 23
CENTRAL BATTERY EQUIPMENT**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes central battery inverters with the following features:
 - 1. Output distribution section.
 - 2. Internal maintenance bypass/isolation switch.
 - 3. External maintenance bypass/isolation switch.
 - 4. Multiple output voltages.
 - 5. Emergency-only circuits.
 - 6. Remote monitoring provisions.

1.3 DEFINITIONS

- A. LCD: Liquid-crystal display.
- B. LED: Light-emitting diode.
- C. THD: Total harmonic distortion.
- D. UPS: Uninterruptible power supply.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Electrical ratings, including the following:
 - a. Capacity to provide power during failure of normal ac.
 - b. Inverter voltage regulation and THD of output current.
 - c. Rectifier data.
 - d. Transfer time of transfer switch.
 - e. Data for specified optional features.
 - 2. Transfer switch.
 - 3. Inverter.
 - 4. Battery charger.
 - 5. Batteries.
 - 6. Battery monitoring.
 - 7. Battery-cycle warranty monitor.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
 - 1. Wiring Diagrams: Detail internal and interconnecting wiring; and power, signal, and control wiring.
 - 2. Elevation and details of control and indication displays.
 - 3. Output distribution section.
- C. Manufacturer Seismic Qualification Certification: Submit certification that central battery inverter equipment will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems" Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."



- b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Qualification Data: For testing agency.
- E. Source quality-control test reports.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For central battery inverter equipment to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of the InterNational Electrical Testing Association or is an NRTL.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Central Battery Inverter System: UL 924 and UL 1778 listed.
- D. Comply with NFPA 70 and NFPA 101.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in fully enclosed vehicles.
- B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.
 - 1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:
 - a. Nickel-Cadmium, Wet-Cell Batteries.
 - 1) Full Warranty: [One year]
 - 2) Pro Rata: [Ten] years.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
 - 1. Fuses: One for every 10 of each type and rating, but no fewer than two of each.
 - 2. Cabinet Ventilation Filters: One complete set.
 - 3. One spare circuit board for each critical circuit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Chloride Systems.
 - 2. Cooper Industries, Inc.; Sure-Lites Division.

3. Dual-Lite.
4. Hubbell Incorporated; Hubbell Lighting.

2.2 INVERTER PERFORMANCE REQUIREMENTS

- A. Slow-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use an electromechanical switch to transfer loads. Transfer in one second or less from normal supply to battery-inverter supply.
 1. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.
- B. Fast-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use a solid-state switch to transfer loads. Transfer in [0.004] second or less from normal supply to battery-inverter supply.
 1. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.
- C. UPS-Type Central Battery Inverters: Continuously provide ac power to connected electrical system.
 1. Automatic Operation:
 - a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, through rectifier-charger and inverter, with battery connected in parallel with rectifier-charger output.
 - b. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, battery supplies constant, regulated, inverter ac power output to the load without switching or disturbance.
 - c. If normal power fails, battery continues supply-regulated ac power through the inverter to the load without switching or disturbance.
 - d. When power is restored at normal supply terminals of system, controls automatically synchronize inverter with the external source before transferring the load. Rectifier-charger then supplies power to the load through the inverter and simultaneously recharges battery.
 - e. If battery becomes discharged and normal supply is available, rectifier-charger charges battery. When battery is fully charged, rectifier-charger automatically shifts to float-charge mode.
 - f. If any element of central battery inverter system fails and power is available at normal supply terminals of system, static bypass transfer switch transfers the load to normal ac supply circuit without disturbance or interruption of supply.
 - g. If a fault occurs in system supplied by central battery inverter and current flows in excess of the overload rating of central battery inverter system, static bypass transfer switch operates to bypass fault current to normal ac supply circuit for fault clearing.
 - h. When fault has cleared, static bypass transfer switch returns the load to central battery inverter system.
 - i. If battery is disconnected, central battery inverter continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.
 2. Manual Operation:
 - a. Turning inverter off causes static bypass transfer switch to transfer the load directly to normal ac supply circuit without disturbance or interruption.
 - b. Turning inverter on causes static bypass transfer switch to transfer the load to inverter.

2.3 SERVICE CONDITIONS

- A. Environmental Conditions: Inverter system shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 1. Ambient Temperature for Electronic Components: [32 to 98 deg F] <
 2. Relative Humidity: [0 to 95] percent, noncondensing.
 3. Altitude: Sea level to [4000 feet].



2.4 INVERTERS

- A. Description: Solid-state type, with the following operational features:
 - 1. Automatically regulate output voltage to within plus or minus 5 percent.
 - 2. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load at unit power factor over the operating range of battery voltage.
 - 3. Output Voltage Waveform of Unit: Sine wave with maximum 10 percent THD throughout battery operating-voltage range, from no load to full load.
 - a. THD may not exceed 5 percent when serving a resistive load of 100 percent of unit rating.
 - 4. Output Protection: Current-limiting and short-circuit protection.
 - 5. Output Protection: Ferroresonant transformer to provide inherent overload and short-circuit protection.
 - 6. Overload Capability: 125 percent for 10 minutes; 150 percent surge.
 - 7. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.

2.5 BATTERY CHARGER

- A. Description: Solid-state, automatically maintaining batteries in fully charged condition when normal power is available. With LED indicators for "float" and "high-charge" modes.

2.6 BATTERIES

- A. Description Nickel-cadmium, dry cell batteries.
 - 1. Capable of sustaining full-capacity output of inverter unit for minimum of [90 minutes].

2.7 ENCLOSURES

- A. NEMA 250, Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
- B. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

2.8 SEISMIC REQUIREMENTS

- A. Central battery inverter assemblies, subassemblies, components, fastenings, supports, and mounting and anchorage devices shall be designed and fabricated to withstand seismic forces. The term "withstand" is defined in the "Manufacturer Seismic Qualification Certification" Paragraph in Part 1 "Submittals" Article.

2.9 CONTROL AND INDICATION

- A. Description: Group displays, indications, and basic system controls on common control panel on front of central battery inverter enclosure.
- B. Minimum displays, indicating devices, and controls shall include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms shall include an audible signal and a visual display.
- C. Indications: **[Labeled LED] [Plain-language messages on a digital LCD or LED]**.
 - 1. Quantitative Indications:
 - a. Input voltage, each phase, line to line.
 - b. Input current, each phase, line to line.
 - c. System output voltage, each phase, line to line.
 - d. System output current, each phase.
 - e. System output frequency.
 - f. DC bus voltage.
 - g. Battery current and direction (charge/discharge).
 - h. Elapsed time-discharging battery.
 - 2. Basic Status Condition Indications:
 - a. Normal operation.
 - b. Load-on bypass.

- c. Load-on battery.
- d. Inverter off.
- e. Alarm condition exists.
- 3. Alarm Indications:
 - a. Battery system alarm.
 - b. Control power failure.
 - c. Fan failure.
 - d. Overload.
 - e. Battery-charging control faulty.
 - f. Input overvoltage or undervoltage.
 - g. Approaching end of battery operation.
 - h. Battery undervoltage shutdown.
 - i. Inverter fuse blown.
 - j. Inverter transformer overtemperature.
 - k. Inverter overtemperature.
 - l. Static bypass transfer switch overtemperature.
 - m. Inverter power supply fault.
 - n. Inverter output overvoltage or undervoltage.
 - o. System overload shutdown.
 - p. Inverter output contactor open.
 - q. Inverter current limit.
- 4. Controls:
 - a. Inverter on-off.
 - b. Start.
 - c. Battery test.
 - d. Alarm silence/reset.
 - e. Output-voltage adjustment.
- D. Dry-form "C" contacts shall be available for remote indication of the following conditions:
 - 1. Inverter on battery.
 - 2. Inverter on-line.
 - 3. Inverter load-on bypass.
 - 4. Inverter in alarm condition.
 - 5. Inverter off (maintenance bypass closed).
- E. Include the following minimum array:
 - 1. Ready, normal-power on light.
 - 2. Charge light.
 - 3. Inverter supply load light.
 - 4. Battery voltmeter.
 - 5. AC output voltmeter with minimum accuracy of 2 percent of full scale.
 - 6. Load ammeter.
 - 7. Test switch to simulate ac failure.
- F. Enclosure: Steel, with hinged lockable doors, suitable for [wall] [floor] mounting. Manufacturer's standard corrosion-resistant finish.

2.10 OPTIONAL FEATURES

- A. Multiple Output Voltages: Supply unit branch circuits at different voltage levels if required. Transform voltages internally as required to produce indicated output voltages.
- B. Emergency-Only Circuits: Automatically energize only when normal supply has failed. Disconnect emergency-only circuits when normal power is restored.

- C. Maintenance Bypass/Isolation Switch: Load is supplied, bypassing central battery inverter system. Normal supply, electromechanical transfer switch, and system load terminals are completely disconnected from external circuits.
- D. Maintenance Bypass/Isolation Switch: Switch is interlocked so it cannot be operated unless static bypass transfer switch is in bypass mode. Switch provides manual selection among the following three conditions without interrupting supply to the load during switching:
 - 1. Full Isolation: Load is supplied, bypassing central battery inverter system. Normal ac input circuit, static bypass transfer switch, and central battery inverter load terminals are completely disconnected from external circuits.
 - 2. Maintenance Bypass: Load is supplied, bypassing central battery inverter system. Central battery inverter ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
 - 3. Normal: Normal central battery inverter ac supply terminals are energized and the load is supplied either through static bypass transfer switch and central battery inverter rectifier-charger and inverter or through battery and inverter.

2.11 OUTPUT DISTRIBUTION SECTION

- A. Panelboard: Comply with Division 26 Section "Panelboards" except provide assembly integral to equipment cabinet.

2.12 SYSTEM MONITORING AND ALARMS

- A. Remote Status and Alarm Panel: Labeled LEDs on panel faceplate shall indicate [five] basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication.
 - 1. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.
- B. Provisions for Remote Computer Monitoring: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in Part 2 "Control and Indication" Article. Remote computer and connecting signal wiring will be provided by Owner. Include the following features:
 - 1. Connectors and network interface units or modems for data transmission via RS-232 link.
 - 2. Software shall be designed to control and monitor inverter system functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of reports. Include capability for storage and analysis of power-line transient records. Software shall be compatible with requirements in Division 26 Section "Electrical Power Monitoring and Control" and the operating system and configuration of Owner-furnished computers.
- C. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.
 - 1. Annunciation of Alarms: At inverter system control panel.
- D. Battery-Cycle Warranty Monitoring: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring charge-discharge cycle history of batteries covered by cycle-life warranty.
 - 1. Basic Functional Performance: Automatically measures and records each discharge event, classifies it according to duration category, and totals discharges according to warranty criteria, displaying remaining warranted battery life on integral LCD.
 - 2. Additional monitoring functions and features shall include the following:
 - a. Measuring and recording of total voltage at battery terminals; providing alarm for excursions outside proper float voltage level.
 - b. Monitoring of ambient temperature at battery and initiating an alarm if temperature deviates from normally acceptable range.
 - c. Keypad on device front panel provides access to monitored data using front panel display.
 - d. Alarm contacts arranged to provide [local] [remote] alarm for [battery discharge events] [abnormal temperature] [abnormal battery voltage or temperature].



- e. Memory device to store recorded data in nonvolatile electronic memory.
- f. RS-232 port to permit downloading of data to a portable personal computer.
- g. Modem to make measurements and recorded data accessible to remote personal computer via telephone line. Computer will be provided by Owner.

2.13 SOURCE QUALITY CONTROL

- A. Factory test complete inverter system[, including battery,] before shipment. Include the following:
 - 1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
 - 2. Full-load test.
 - 3. Transient-load response test.
 - 4. Overload test.
 - 5. Power failure test.
- B. Observation of Test: Give 14 days' advance notice of tests and provide access for Owner's representative to observe tests at Owner's option.
- C. Report test results. Include the following data:
 - 1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
 - 2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
 - 3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install system components on **[floor] [concrete base]** and attach by bolting.
 - 1. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for seismic-restraint requirements.
 - 2. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 3 inches in all directions beyond the maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."
 - 3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 5. Use **[3000-psi] <Insert value>**, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "**[Cast-in-Place Concrete] [Miscellaneous Cast-in-Place Concrete]**."
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 CONNECTIONS

- A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.



- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

- A. Identify equipment and components according to Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
 - 2. Test manual and automatic operational features and system protective and alarm functions.
 - 3. Test communication of status and alarms to remote monitoring equipment.
 - 4. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specifications. Certify compliance with test parameters.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Remove and replace malfunctioning units and retest as specified above.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Verify that central battery inverter is installed and connected according to the Contract Documents.
- C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.
- D. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING AND CLEANING

- A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- B. Install new filters in each equipment cabinet within 14 days from date of Substantial Completion.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery inverters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 33 23



**SECTION 26 33 53
STATIC UNINTERRUPTIBLE POWER SUPPLY**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Three-phase, on-line, double-conversion, static-type, UPS units with the following features:
 - a. Surge suppression.
 - b. Input harmonics reduction.
 - c. Rectifier-charger.
 - d. Inverter.
 - e. Static bypass transfer switch.
 - f. Battery and battery disconnect device.
 - g. **[Internal] [External]** maintenance bypass/isolation switch.
 - h. Output isolation transformer.
 - i. Remote UPS monitoring provisions.
 - j. Battery monitoring.
 - k. Remote monitoring.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. LCD: Liquid-crystal display.
- C. LED: Light-emitting diode.
- D. NETA: InterNational Electrical Testing Association.
- E. PC: Personal computer.
- F. THD: Total harmonic distortion.
- G. UPS: Uninterruptible power supply.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: UPS shall withstand the effects of earthquake motions determined according to **[ASCE/SEI 7]**.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include data on features, components, ratings, and performance.
- B. Shop Drawings: For UPS. Include plans, elevations, sections, details, and attachments to other work. Drawings shall be drawn to scale (1/4"=1'-0").
 - 1. Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
 - 2. Wiring Diagrams: For power, signal, and control wiring. Differentiate between manufacturer installed and field installed wiring.



1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified **[power quality specialist]** and **[testing agency]**.
- B. Seismic Qualification Certificates: For UPS equipment, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Manufacturer Certificates: For each product, from manufacturer.
- D. Factory Test Reports: Comply with specified requirements.
- E. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- F. Performance Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.
- G. Warranties: Sample of special warranties.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For UPS units to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: **[one]** for every **[10]** of each type and rating, but no fewer than **[three]** of each.
 - 2. Cabinet Ventilation Filters: **[two]** complete set(s).

1.9 QUALITY ASSURANCE

- A. American made products have been acceptable to the Owner. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the Owner and all tests shall be witnessed by Owner's personnel. Testing procedures and test results shall be satisfactory to the Owner. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one Owner's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- B. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of Static UPS similar to the type and size specified in this project.
- C. Manufacturer shall have ISO 9001 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer confirming the availability.
- E. UPS shall be assembled at the manufacturer's own manufacturing facility using its own major components (e.g., inverters, trip units) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- F. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Controllers shall be manufactured within six months of installation.



- G. Source Limitations: Obtain UPS, overcurrent protective devices, components, and accessories, within same product category, through one source from a single manufacturer through a local distributor unless otherwise noted.
- H. Comply with NFPA 70.
- I. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- J. Product Options: Drawings indicate size, profiles, and dimensional requirements of UPS are based on the specific system indicated.
- K. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100, and marked for intended location and application.
- L. Testing Agency Qualifications: Member of NETA;
 - 1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of last ten (10) years and has permanent in-house testing engineers and technicians involved with testing of UPS, OCPDs, switches and breakers similar to those specified on this project.
 - 2. Testing company shall be located with 50 miles radius of the project.
 - 3. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
 - 4. Field Testing technician and supervisor shall have minimum ten (10) years experience in field testing of UPS, OCPDs, switches and circuit breakers similar to the type and rating specified on this project.
- M. Power Quality Specialist Qualifications: A registered professional electrical engineer or engineering technician, currently certified by the National Institute for Certification in Engineering Technologies, NICET Level 4, minimum, experienced in performance testing UPS installations and in performing power quality surveys similar to that required in "Performance Testing" Article.
- N. UL Compliance: Complete UPS assembly shall be UL Listed and labeled under UL 1778.
- O. NFPA Compliance: Mark UPS components as suitable for installation in computer rooms according to NFPA 75.

1.10 WARRANTY

- A. Special Battery Warranties: Specified form in which manufacturer and Installer agree to repair or replace on site UPS system storage batteries that fail in materials or workmanship within specified warranty period. Warranty shall cover labor and materials.
 - 1. Warranted Cycle Life for Valve-Regulated, Lead-Calcium Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F:

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.67	6 cycles
30 minutes	30 minutes	1.67	20 cycles
15 minutes	45 seconds	1.67	120 cycles



2. Warranted Cycle Life for Premium Valve-Regulated, Lead-calcium Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F:

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.67	40 cycles
30 minutes	30 minutes	1.67	125 cycles
15 minutes	1.5 minutes	1.67	750 cycles

3. Warranted Cycle Life for Flooded Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F:

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.75	40 cycles
1 hour	1 hour	1.75	80 cycles
15 minutes	45 seconds	1.67	2700 cycles

- B. Special UPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within special warranty period.
 1. Special Warranty Period: [Three] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OPERATIONAL REQUIREMENTS

- A. Automatic operation includes the following:
 1. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
 2. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter power output to the load without switching or disturbance.
 3. If normal power fails, energy supplied by the battery through the inverter continues supply-regulated power to the load without switching or disturbance.
 4. When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.
 5. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery. On reaching full charge, the rectifier-charger automatically shifts to float-charge mode.
 6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the load to the normal ac supply circuit without disturbance or interruption.
 7. If a fault occurs in the system supplied by the UPS, and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.
 8. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.
 9. If the battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.
- B. Manual operation includes the following:
 1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.



- 2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.
- C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection among the three conditions in subparagraphs below without interrupting supply to the load during switching:
 - 1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
 - 2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
 - 3. Normal: Normal UPS ac supply terminals are energized and the load is supplied through either the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.
- D. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.
 - 1. Ambient Temperature for Electronic Components: 32 to 104 deg F.
 - 2. Ambient Temperature for Battery: 41 to 95 deg F.
 - 3. Relative Humidity: 0 to 95 percent, noncondensing.
 - 4. Altitude: Sea level to 4000 feet.

2.2 PERFORMANCE REQUIREMENTS

- A. The UPS shall perform as specified in this section while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:
 - 1. Inverter is switched to battery source.
 - 2. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.
 - 3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
 - 4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
 - 5. Load is [30] percent unbalanced continuously.
- B. Minimum Duration of Supply: If battery is sole energy source supplying rated full UPS load current at 80 percent power factor, duration of supply is [15] minutes.
- C. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10, minus [15] [20] [30] percent from nominal voltage.
- D. Overall UPS Efficiency: See minimum limits below. Equal to or greater than <Insert number> percent at 100 percent load, <Insert number> percent at 75 percent load, and <Insert number> percent at 50 percent load.

UNIT	% Full Load				
	20%	40%	60%	80%	100%
100 kVA	92.5%	94.3%	95.0%	95.2%	95.8%
160 kVA	94.7%	95.7%	96.2%	96.5%	96.5%
225 kVA	94.9%	96.2%	96.5%	96.5%	96.5%
300 kVA	94.4%	96.3%	96.9%	97.0%	97.0%
500 kVA	94.8%	96.7%	97.0%	97.0%	97.0%
750 kVA	95.5%	96.6%	97.0%	97.0%	97.0%

- E. Maximum Acoustical Noise: **70 dB for 100-225 KVA and 73 dB for 300-750KVA**, "A" weighting, emanating from any UPS component under any condition of normal operation, measured AT 3.3 feet (1m) from nearest surface of component enclosure.
- F. Maximum Energizing Inrush Current: [Six] [Eight] times the full-load current.



- G. Maximum AC Output-Voltage Regulation for Loads up to 50 Percent Unbalanced: Plus or minus 2 percent over the full range of battery voltage.
- H. Output Frequency: 60 Hz, plus or minus 0.5 percent over the full range of input voltage, load, and battery voltage.
- I. Limitation of harmonic distortion of input current to the UPS shall be as follows:
 - 1. Description: Either a tuned harmonic filter or an arrangement of rectifier-charger circuits shall limit THD to [5] percent, maximum, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.
- J. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for 100 percent rated nonlinear load current with a load crest factor of 3.0.
- K. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for rated full load with THD up to 50 percent, with a load crest factor of 3.0.
- L. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 2 minutes, 150 percent for 60 seconds for sizes 100-225KVA and 125 percent of rated full load for 10 minutes 150 percent for 60 seconds for 330-750KVA in all operating modes.
- M. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 100 ms:
 - 1. 50 Percent: Plus or minus 5 percent.
 - 2. 100 Percent: Plus or minus 5 percent.
 - 3. Loss of AC Input Power: Plus or minus 1 percent.
 - 4. Restoration of AC Input Power: Plus or minus 1 percent.
- N. Input Power Factor: A minimum of [0.85] lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current.
- O. EMI Emissions: Comply with FCC Rules and Regulations and with 47 CFR 15 for Class A equipment.

2.3 UPS SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following manufacturers**
 - 1. Eaton Corporation; Powerware Division.
 - 2. Liebert Corporation; a division of Emerson.
 - 3. MGE UPS SYSTEMS.
 - 4. Mitsubishi Electric Automation, Inc.
 - 5. Toshiba Corporation; Industrial Systems.
- B. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.
- C. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.
- D. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.
- E. Surge Suppression: Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch, static bypass transfer switch[, **and maintenance bypass/isolation switch**]. Protect rectifier-charger, inverter, controls, and output components.
 - 1. Use factory-installed surge suppressors tested according to IEEE C62.41.1 and IEEE C62.41.2, **[Category B] [Category C]**.
 - 2. Additional Surge Protection: Protect internal UPS components from low-frequency, high-energy voltage surges described in IEEE C62.41.1 and IEEE C62.41.2. Design the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength

and thermal and current-carrying capacity to withstand stresses imposed by 40-Hz, 180 percent voltage surges described in IEEE C62.41.1 and IEEE C62.41.2.

- F. Maintainability Features: Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.
- G. Seismic-Restraint Design: UPS assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.
- H. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.
- I. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.4 RECTIFIER-CHARGER

- A. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.
- B. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.
- C. Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.
 - 1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.
- D. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.

2.5 INVERTER

- A. Description: Pulse-width modulated, with sinusoidal output.
- B. Description: Pulse-width modulated, with sinusoidal output. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

2.6 STATIC BYPASS TRANSFER SWITCH

- A. Description: Solid-state switching device providing uninterrupted transfer. A contactor or electrically operated circuit breaker automatically provides electrical isolation for the switch.
- B. Switch Rating: Continuous duty at the rated full UPS load current, minimum.

2.7 BATTERY

- A. Description: Valve-regulated, recombinant, lead-calcium units, factory assembled in an isolated compartment of UPS cabinet, complete with battery disconnect switch.
 - 1. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.
- B. Description: Valve-regulated, premium, heavy-duty, recombinant, lead-calcium units; factory assembled in an isolated compartment or in a separate matching cabinet, complete with battery disconnect switch.
 - 1. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.
- C. Description: Flooded, lead-calcium, heavy-duty industrial units in styrene acrylonitrile containers mounted on[**three-tier,**] acid-resistant, painted steel racks. Assembly includes battery disconnect switch, intercell connectors, hydrometer syringe, and thermometer with specific gravity-correction scales.
- D. Manufacturers: Subject to compliance with requirements, **provide products by one of the following manufacturers**
 - 1. C&D Technologies, Inc.; Standby Power Division.
 - 2. Eaton Corporation; Powerware Division.
 - 3. EnerSys.
 - 4. Panasonic Corporation of North America; Panasonic Industrial Company.

- E. Seismic-Restraint Design: Battery racks, cabinets, assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.

2.8 CONTROLS AND INDICATIONS

- A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.
- B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.
- C. Indications: **[Labeled LED] [Plain-language messages on a digital LCD or LED]**.
 - 1. Quantitative indications shall include the following:
 - a. Input voltage, each phase, line to line.
 - b. Input current, each phase, line to line.
 - c. Bypass input voltage, each phase, line to line.
 - d. Bypass input frequency.
 - e. System output voltage, each phase, line to line.
 - f. System output current, each phase.
 - g. System output frequency.
 - h. DC bus voltage.
 - i. Battery current and direction (charge/discharge).
 - j. Elapsed time discharging battery.
 - 2. Basic status condition indications shall include the following:
 - a. Normal operation.
 - b. Load-on bypass.
 - c. Load-on battery.
 - d. Inverter off.
 - e. Alarm condition.
 - 3. Alarm indications shall include the following:
 - a. Bypass ac input overvoltage or undervoltage.
 - b. Bypass ac input overfrequency or underfrequency.
 - c. Bypass ac input and inverter out of synchronization.
 - d. Bypass ac input wrong-phase rotation.
 - e. Bypass ac input single-phase condition.
 - f. Bypass ac input filter fuse blown.
 - g. Internal frequency standard in use.
 - h. Battery system alarm.
 - i. Control power failure.
 - j. Fan failure.
 - k. UPS overload.
 - l. Battery-charging control faulty.
 - m. Input overvoltage or undervoltage.
 - n. Input transformer overtemperature.
 - o. Input circuit breaker tripped.
 - p. Input wrong-phase rotation.
 - q. Input single-phase condition.
 - r. Approaching end of battery operation.
 - s. Battery undervoltage shutdown.
 - t. Maximum battery voltage.
 - u. Inverter fuse blown.



- v. Inverter transformer overtemperature.
- w. Inverter overtemperature.
- x. Static bypass transfer switch overtemperature.
- y. Inverter power supply fault.
- z. Inverter transistors out of saturation.
- aa. Identification of faulty inverter section/leg.
- bb. Inverter output overvoltage or undervoltage.
- cc. UPS overload shutdown.
- dd. Inverter current sensor fault.
- ee. Inverter output contactor open.
- ff. Inverter current limit.
- 4. Controls shall include the following:
 - a. Inverter on-off.
 - b. UPS start.
 - c. Battery test.
 - d. Alarm silence/reset.
 - e. Output-voltage adjustment.
- D. Dry-form "C" contacts shall be available for remote indication of the following conditions:
 - 1. UPS on battery.
 - 2. UPS on-line.
 - 3. UPS load-on bypass.
 - 4. UPS in alarm condition.
 - 5. UPS off (maintenance bypass closed).
- E. Emergency Power Off Switch: Capable of local operation and operation by means of activation by external dry contacts.

2.9 MAINTENANCE BYPASS/ISOLATION SWITCH

- A. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.
 - 1. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
 - 2. Switch shall electrically isolate other UPS components to permit safe servicing.
- B. Comply with NEMA PB 2 and UL 891.
- C. Switch Rating: Continuous duty at rated full UPS load current.
- D. Mounting Provisions: [**Internal to system cabinet**] [**Separate wall- or floor-mounted unit**].
- E. Key interlock requires unlocking maintenance bypass/isolation switch before switching from normal position with key that is released only when the UPS is bypassed by the static bypass transfer switch. Lock is designed specifically for mechanical and electrical component interlocking.

2.10 OUTPUT ISOLATION TRANSFORMER

- A. Description: **Shielded unit** with low forward transfer impedance up to 3 kHz, minimum. Include the following features:
 - 1. Comply with applicable portions of UL 1561, including requirements for nonlinear load current-handling capability for a K-factor of approximately [4] [9] [13] [20].
 - 2. Output Impedance at Fundamental Frequency: Between 3 and 4 percent.
 - 3. Regulation: 5 percent, maximum, at rated nonlinear load current.
 - 4. Full-Load Efficiency at Rated Nonlinear Load Current: 96 percent, minimum.
 - 5. Electrostatic Shielding of Windings: Independent for each winding.
 - 6. Coil Leads: Physically arranged for minimum interlead capacitance.

7. Shield Grounding Terminal: Separately mounted; labeled "Shield Ground."
8. Capacitive Coupling between Primary and Secondary: 33 picofarads, maximum, over a frequency range of 20 Hz to 1 MHz.

2.11 OUTPUT DISTRIBUTION SECTION

- A. Panelboards: Comply with Section 262416 "Panelboards" except provide assembly integral to UPS cabinet.

2.12 MONITORING BY REMOTE STATUS AND ALARM PANEL

- A. Description: Labeled LEDs on panel faceplate indicate [**five**] basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication.
 1. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.

2.13 BASIC BATTERY MONITORING

- A. Manufacturers: Subject to compliance manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Albercorp.
 2. BTECH, Inc.
 3. Eaton Corporation; Powerware Division.
- B. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.
- C. Battery compartment smoke/high-temperature detector initiates an alarm when smoke or a temperature greater than 75 deg C occurs within the compartment.
- D. Annunciation of Alarms: At UPS control panel.

2.14 ADDITIONAL BATTERY MONITORING

- A. Monitoring features and components shall include the following:
 1. Factory-wired sensing leads to cell and battery terminals and cell temperature sensors.
 2. Connections for data transmission via RS-232 link, [network interface and] [modem and] external signal wiring to [computer] [electrical power monitoring and control equipment]. External signal wiring and computer are not specified in this Section.
 3. PC-based software designed to store and analyze battery data. Software compiles reports on individual-cell parameters and total battery performance trends, and provides data for scheduling and prioritizing battery maintenance.
- B. Performance: Automatically measures and electronically records the following parameters on a routine schedule and during battery discharge events. During discharge events, records measurements timed to nearest second; includes measurements of the following parameters:
 1. Total battery voltage and ambient temperature.
 2. Individual-cell voltage, impedance, and temperature. During battery-discharging events such as utility outages, measures battery and cell voltages timed to nearest second.
 3. Individual-cell electrolyte levels.

2.15 BATTERY-CYCLE WARRANTY MONITORING

- A. Description: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring of charge-discharge cycle history of batteries covered by cycle-life warranties.
- B. Performance: Automatically measures and records each discharge event, classifies it according to duration category, and totals discharges according to warranty criteria, displaying remaining warranted battery life on front panel display.
- C. Additional monitoring functions and features shall include the following:



1. Measuring and Recording: Total voltage at battery terminals; initiates alarm for excursions outside the proper float-voltage level.
2. Monitors: Ambient temperature at battery; initiates alarm if temperature deviates from normally acceptable range.
3. Keypad on Device Front Panel: Provides access to monitored data using front panel display.
4. Alarm Contacts: Arranged to initiate **[local] [remote]** alarm for **[battery discharge events] [abnormal temperature] [abnormal battery voltage or temperature]**.
5. Memory: Stores recorded data in nonvolatile electronic memory.
6. RS-232 Port: Permits downloading of data to a portable PC.
7. Modem: Makes measurements and recorded data accessible to a remote PC via telephone line. Computer is not specified in this Section.

2.16 SOURCE QUALITY CONTROL

- A. Factory test complete UPS system before shipment. Use **[actual batteries that are part of final installation] [simulated battery testing]**. Include the following:
 1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
 2. Full-load test.
 3. Transient-load response test.
 4. Overload test.
 5. Power failure test.
- B. Observation of Test: Give 14 days' advance notice of tests and provide opportunity for Owner's representative to observe tests at Owner's choice.
- C. Report test results. Include the following data:
 1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
 2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
 3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the UPS.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Equipment Mounting: Install UPS on concrete base. Comply with requirements for concrete base specified in **[Section 03 30 00 "Cast-in-Place Concrete.]" [Section 03 30 53 "Miscellaneous Cast-in-Place Concrete.]"**
 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- C. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.



3.3 GROUNDING

- A. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.

3.4 IDENTIFICATION

- A. Identify components and wiring according to Section 26 05 53 "Identification for Electrical Systems."
 - 1. Identify each battery cell individually.

3.5 BATTERY EQUALIZATION

- A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Comply with manufacturer's written instructions.
 - 2. Inspect interiors of enclosures, including the following:
 - a. Integrity of mechanical and electrical connections.
 - b. Component type and labeling verification.
 - c. Ratings of installed components.
 - 3. Inspect batteries and chargers according to requirements in NETA Acceptance Testing Specifications.
 - 4. Test manual and automatic operational features and system protective and alarm functions.
 - 5. Test communication of status and alarms to remote monitoring equipment.
 - 6. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous [**six months**] according to NIST standards.
 - a. Simulate malfunctions to verify protective device operation.
 - b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
 - c. Test harmonic content of input and output current less than 25, 50, and 100 percent of rated loads.
 - d. Test output voltage under specified transient-load conditions.
 - e. Test efficiency at 50, 75, and 100 percent of rated loads.
 - f. Test remote status and alarm panel functions.
 - g. Test battery-monitoring system functions.
- E. Seismic-restraint tests and inspections shall include the following:
 - 1. Inspect type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.
 - 2. Test mounting and anchorage devices according to requirements in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- F. The UPS system will be considered defective if it does not pass tests and inspections.



- G. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.
- H. Prepare test and inspection reports.

3.7 PERFORMANCE TESTING

- A. Engage the services of a qualified power quality specialist to perform tests and activities indicated[**for each UPS system**].
- B. Monitoring and Testing Schedule: Perform monitoring and testing in [**a single 10-day period**] .
 - 1. Schedule monitoring and testing activity with Owner, through Architect, with at least 14 days' advance notice.
 - 2. Schedule monitoring and testing after Substantial Completion, when the UPS is supplying power to its intended load.
- C. Monitoring and Testing Instruments: Three-phase, recording, power monitors. Instruments shall provide continuous simultaneous monitoring of electrical parameters at UPS input terminals and at input terminals of loads served by the UPS. Instruments shall monitor, measure, and graph voltage current and frequency simultaneously and provide full-graphic recordings of the values of those parameters before and during power-line disturbances that cause the values to deviate from normal beyond the adjustable threshold values. Instruments shall be capable of recording either on paper or on magnetic media and have a minimum accuracy of plus or minus 2 percent for electrical parameters. Parameters to be monitored include the following:
 - 1. Current: Each phase and neutral and grounding conductors.
 - 2. Voltage: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
 - 3. Frequency transients.
 - 4. Voltage swells and sags.
 - 5. Voltage Impulses: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
 - 6. High-frequency noise.
 - 7. Radio-frequency interference.
 - 8. THD of the above currents and voltages.
 - 9. Harmonic content of currents and voltages above.
- D. Monitoring and Testing Procedures[**for Each Test Period**]:
 - 1. Exploratory Period: For the first [**two**] days[**of the first scheduled monitoring and testing period**], make recordings at various circuit locations and with various parameter-threshold and sampling-interval settings. Make these measurements with the objective of identifying optimum UPS, power system, load, and instrumentation setup conditions for subsequent test and monitoring operations.
 - 2. Remainder of Test Period: Perform continuous monitoring of at least two circuit locations selected on the basis of data obtained during exploratory period.
 - a. Set thresholds and sampling intervals for recording data at values selected to optimize data on performance of the UPS for values indicated, and to highlight the need to adjust, repair, or modify the UPS, distribution system, or load component that may influence its performance or that may require better power quality.
 - b. Perform load and UPS power source switching and operate the UPS on generator power during portions of test period according to directions of Owner's power quality specialist.
 - c. Operate the UPS and its loads in each mode of operation permitted by UPS controls and by the power distribution system design.
 - d. Using loads and devices available as part of the facility's installed systems and equipment[**and a temporarily connected portable generator set**], create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients. Maintain normal operating loads in operation on system to maximum extent possible during tests.

- e. Using temporarily connected resistive/inductive load banks[**and a temporarily connected portable generator set**], create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients. Maintain normal operating loads in operation on system to maximum extent possible during tests.
 - f. Make adjustments and repairs to UPS, distribution, and load equipment to correct deficiencies disclosed by monitoring and testing and repeat appropriate monitoring and testing to verify success of corrective action.
- E. Coordination with Specified UPS Monitoring Functions: Obtain printouts of built-in monitoring functions specified for the UPS and its components in this Section that are simultaneously recorded with portable instruments in this article.
- 1. Provide the temporary use of an appropriate PC and printer equipped with required connections and software for recording and printing if such units are not available on-site.
 - 2. Coordinate printouts with recordings for monitoring performed according to this article, and resolve and report any anomalies in and discrepancies between the two sets of records.
- F. Monitoring and Testing Assistance by Contractor:
- 1. Open UPS and electrical distribution and load equipment and wiring enclosures to make monitoring and testing points accessible for temporary monitoring probe and sensor placement and removal as requested.
 - 2. Observe monitoring and testing operations; ensure that UPS and distribution and load equipment warranties are not compromised.
 - 3. Perform switching and control of various UPS units, electrical distribution systems, and load components as directed by power quality specialist. Specialist shall design this portion of monitoring and testing operations to expose the UPS to various operating environments, conditions, and events while response is observed, electrical parameters are monitored, and system and equipment deficiencies are identified.
 - 4. Make repairs and adjustments to the UPS and to electrical distribution system and load components, and retest and repeat monitoring as needed to verify validity of results and correction of deficiencies.
 - 5. Engage the services of the UPS manufacturer's factory-authorized service representative periodically during performance testing operations for repairs, adjustments, and consultations.
- G. Documentation: Record test point and sensor locations, instrument settings, and circuit and load conditions for each monitoring summary and power disturbance recording. Coordinate simultaneous recordings made on UPS input and load circuits.
- H. Analysis of Recorded Data and Report: Review and analyze test observations and recorded data and submit a detailed written report. Include the following in **[each]** report:
- 1. Description of corrective actions performed during monitoring and survey work and their results.
 - 2. Recommendations for further action to provide optimum performance by the UPS and appropriate power quality for non-UPS loads. Include a statement of priority ranking and a cost estimate for each recommendation that involves system or equipment revisions.
 - 3. Copies of monitoring summary graphics and graphics illustrating harmonic content of significant voltages and currents.
 - 4. Copies of graphics of power disturbance recordings that illustrate findings, conclusions, and recommendations.
 - 5. Recommendations for operating, adjusting, or revising UPS controls.
 - 6. Recommendation for alterations to the UPS installation.
 - 7. Recommendations for adjusting or revising generator-set or automatic transfer switch installations or their controls.
 - 8. Recommendations for power distribution system revisions.
 - 9. Recommendations for adjusting or revising electrical loads, their connections, or controls.
- I. Interim and Final Reports: Provide an interim report at the end of each test period and a final comprehensive report at the end of final test and analysis period.



3.8 DEMONSTRATION

- A. **[Engage a factory-authorized service representative to train]** Owner's maintenance personnel to adjust, operate, and maintain the UPS.

END OF SECTION 26 33 53

**SECTION 26 36 00
TRANSFER SWITCHES**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switches.
 - 2. Bypass/isolation switches.
 - 3. Nonautomatic transfer switches.
 - 4. Remote annunciation systems.
 - 5. Remote annunciation and control systems.

1.3 DEFINITIONS

- A. ATS: Automatic Transfer Switch
- B. BP/IS: Bypass switch and Isolation Switch
- C. EMI: Electromagnetic interference.
- D. LCD: Liquid-crystal display.
- E. LED: Light-emitting diode.
- F. NETA: InterNational Electrical Testing Association.
- G. PC: Personal computer.
- H. THD: Total harmonic distortion.
- I. UPS: Uninterruptible power supply.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: UPS shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances on all sides, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified. Drawings shall be drawn to scale (1/4"=1'-0").
 - 1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and testing agency.
- B. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.



- a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control test reports.
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
1. Features and operating sequences, both automatic and manual.
 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.8 QUALITY ASSURANCE

- A. American made products have been acceptable to the Owner. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the Owner and all tests shall be witnessed by Owner's personnel. Testing procedures and test results shall be satisfactory to the Owner. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one Owner's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 75 of Project site, a service center capable of providing training, parts, and emergency maintenance repairs within 8 hours from the time of notification.
- C. Contractor shall ensure that the manufacturer has a minimum of 15 years experience in the production of Emergency/Standby Engine Generators similar to the type and size specified in this project. Furnish a list of three (3) contacts for the three (3) similar projects completed within the last 5 years. Include name, tele no and email of the facility engineers.
- D. Manufacturer shall have ISO 9001 or 9002 Certification.
- E. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer confirming the availability.
- F. Transfer Switch shall be assembled at the manufacturer's own manufacturing facility using its own major devices (e.g., contactors) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- G. Transfer Switch shall comply with seismic zone applicable to the project. Unless otherwise indicated, verify requirements with Architect or Structural Engineer of Record (SEOR). Provide certified test reports of shake table test done by manufacturer on similar units.
- H. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Major components (e.g. contactors, controls) shall be manufactured within six months of installation.



- I. Source Limitations: Obtain automatic transfer switches remote annunciators through one source from a single manufacturer switch, and accessories through one source from a single manufacturer through a local distributor.
- J. Product Options: Drawings indicate size, profiles, and dimensional requirements of engine generators and are based on the specific system indicated.
- K. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100, and marked for intended location and application.
- L. Testing Agency Qualifications: Member of NETA;
 - 1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of ten (10) years and has permanent in-house testing engineers and technicians involved with testing of transfer switches, switchboards, panelboards and OCPDs similar to those specified on this project.
 - 2. Testing company shall be located with 50 miles radius of the project.
 - 3. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
- M. Comply with NEMA ICS 1.
- N. Comply with NFPA 70.
- O. Comply with NFPA 99.
- P. Comply with NFPA 110.
- Q. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.9 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
 - 1. Notify Construction Manager and College no fewer than fourteen (14) days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Construction Manager's and College's written permission.

1.10 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Russellectric Inc
 - 2. Emerson; ASCO Power Technologies, LP.
 - 3. GE Zenith Controls.
 - 4. Kohler Power Systems; Generator Division.
 - 5. Onan/Cummins Power Generation; Industrial Business Group.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location. Verify maximum available fault levels from the Short Circuit and Coordination Study.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
 2. Switch Action: Double throw; mechanically held in both directions.
 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- G. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- H. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.
- I. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater. Thermostat shall be accessible for operator control.
- J. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
- K. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Section 26 05 53 "Identification for Electrical Systems."
 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- G. Automatic Open-Transition Transfer Switches: Include the following functions and characteristics:



1. Fully automatic make-before-break operation.
 2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
 3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.
 - a. Initiation occurs without active control of generator.
 - b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.
 4. Failure of power source serving load initiates automatic break-before-make transfer.
- H. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
- I. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.
- J. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.
- K. Automatic Transfer-Switch Features:
1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
 4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
 5. Test Switch: Simulate normal-source failure.
 6. Switch-Position Pilot Lights: Indicate source to which load is connected.
 7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
 8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
 9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is not available.

2.4 REMOTE ANNUNCIATOR SYSTEM

- A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:
 1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
 2. Switch position.
 3. Switch in test mode.
 4. Failure of communication link.
 5. Fail to transfer.
- B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
 1. Indicating Lights: Grouped for each transfer switch monitored.
 2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
 3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
 4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.5 REMOTE ANNUNCIATOR AND CONTROL SYSTEM

- A. Functional Description: Include the following functions for indicated transfer switches:
 1. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
 2. Indication of switch position.
 3. Indication of switch in test mode.
 4. Indication of failure of digital communication link.
 5. Key-switch or user-code access to control functions of panel.
 6. Control of switch-test initiation.
 7. Control of switch operation in either direction.
 8. Control of time-delay bypass for transfer to normal source.
- B. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
- C. Remote Annunciation and Control Panel: Solid-state components. Include the following features:
 1. Controls and indicating lights grouped together for each transfer switch.
 2. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
 3. Digital Communication Capability: Matched to that of transfer switches supervised.



4. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

2.6 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."
- B. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
- C. Identify components according to Section 26 05 53 "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Perform tests and inspections and prepare test reports.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
 2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

- f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
- g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
- D. Testing Agency's Tests and Inspections:
 1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 2. Perform each visual and mechanical inspection and electrical test stated in latest edition of NETA Acceptance Testing Specification. Certify compliance with test parameters.
 3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
- E. Coordinate tests with tests of generator and run them concurrently.
- F. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- G. Remove and replace malfunctioning units and retest as specified above.
- H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.



3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Section 01 79 00 "Demonstration and Training." Training shall be held on site after the all transfer switches are completely installed, tested and fully functional.
- B. Coordinate this training with that for generator equipment.

END OF SECTION 26 36 00



SECTION 26 43 13
SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.
- B. Related Requirements:
 - 1. Section 26 24 13 "Switchboards" for factory-installed SPDs.
 - 2. Section 26 24 16 "Panelboards" for factory-installed SPDs.

1.3 DEFINITIONS

- A. I nominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Product Certificates: For transient voltage surge suppression devices, signed by the product manufacturer certifying compliance with the following standards UL 1449 and UL 1283.
 - 3. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, I nominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports. Include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with the requirements.
 - 3. Failed test results and corrective action taken to achieve the requirements.
- B. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For SPDs to include emergency, operation and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. American made products have been acceptable to the Owner. If non-domestic products are submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. Testing shall be done by a recognized lab acceptable to the Owner and all tests shall be



witnessed by Owner's personnel. Testing procedures and test results shall be satisfactory to the College. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one Owner's representative to witness the test at the testing lab. Include all costs for the above in the bid.

- B. Contractor shall ensure that the manufacturer has a minimum of 15 years' experience in the production of Surge Protective Devices (SPDs) similar to the type and size specified in this project.
- C. Manufacturer shall have ISO 9001 Certification.
- D. Manufacturer shall have ability to readily provide replacement parts for a minimum period of ten (10) years, from the date of completion of the project. Furnish a letter from the manufacturer confirming the availability.
- E. Surge Protective Devices (SPDs) shall be assembled at the manufacturer's own manufacturing facility using its own major components (e.g., trip units) for the assembly. These devices shall be normally carried by the manufacturer as standard catalog items.
- F. Provide certified test reports of shake table test done by manufacturer on similar units.
- G. Materials and equipment shall be new, modern in design and shall not have been in prior service except as required by factory tests. Controllers shall be manufactured within six months of installation.
- H. Source Limitations: Obtain Surge Protective Devices (SPDs), overcurrent protective devices, components, and accessories, within same product category, through one source from a single manufacturer through a local distributor unless otherwise noted.
- I. Comply with NFPA 70.
- J. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- K. Product Options: Drawings indicate size, profiles, and dimensional requirements of Surge Protective Devices (SPDs) are based on the specific system indicated.
- L. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100 and marked for intended location and application.
- M. Testing Agency Qualifications: Member of NETA;
 - 1. Testing agency shall be an independent company; shall have been a member of NETA for a minimum of last ten (10) years and has permanent in-house testing engineers and technicians involved with testing of Surge Protective Devices, OCPDs, switches and breakers similar to those specified on this project.
 - 2. Testing company shall be located with 50 miles radius of the project.
 - 3. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing to supervise on-site testing specified in Part 3.
 - 4. Field Testing technician and supervisor shall have minimum ten (10) years' experience in field testing of Surge Protective Devices (SPDs), OCPDs, switches and circuit breakers similar to the type and rating specified on this project.

1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:
 - 1. Schneider Electric Industries SAS



2. Advanced Protection Technologies Inc. (APT).
3. Eaton Corporation.
4. GE Zenith Controls.
5. LEA International; Protection Technology Group.
6. Leviton Manufacturing Co., Inc.
7. PowerLogics, Inc..
8. Siemens Industry, Inc.

2.2 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: UL Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Comply with UL 1449 and 1283
- D. Comply with ANSI/IEEE C62.41-2002 and C62.5-2002
- E. MCOV of the SPD shall be at least 125 percent of the nominal system voltage.

2.3 PANEL SUPPRESSORS

- A. SPDs: Comply with UL 1449, [Type 1] [Type 2].
 1. Include LED indicator lights for power and protection status.
 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
- B. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- C. Comply with UL 1283.
- D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
 1. Line to Neutral: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
 2. Line to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
 3. Neutral to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
 4. Line to Line: 2000 V for 480Y/277 V and 1200 V for 208Y/120 V.
- E. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
 1. Line to Neutral: 700 V.
 2. Line to Ground: 700 V.
 3. Neutral to Ground: 700 V.
 4. Line to Line: 1200 V.
- F. SCCR: Equal or exceed 100 kA.
- G. I nominal Rating: 20 kA.

2.4 ENCLOSURES

- A. Indoor Enclosures: NEMA 250, Type 1.
- B. Outdoor Enclosures: NEMA 250, Type 4X. Outdoor enclosure shall have temper proof screws and be lockable with a padlock.



2.5 CONDUCTORS AND CABLES

- A. Power Wiring: Same size as SPD leads, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. Wiring:
 - 1. Power Wiring: Comply with wiring methods in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
 - 2. Controls: Comply with wiring methods in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 26 43 13



**SECTION 26 51 00
INTERIOR LIGHTING**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior lighting fixtures, lamps, ballasts, and drivers.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.
 - 5. Retrofit kits for fluorescent lighting fixtures.
- B. Related Sections:
 - 1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.2 REFERENCES

- A. ANSI/NFPA 70, National Electrical Code
- B. IESNA LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products
- C. IESNA LM-80, Approved Method for Measuring Lumen Maintenance of LED Light Sources
- D. IESNA TM-21, Luminaire Classification System for Indoor Luminaires
- E. UL1598, Standard for Safety of Luminaires

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, and finishes.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Luminaires shall be fully assembled and individually electrically tested prior to shipment.
- D. Manufacturers of LED luminaires shall demonstrate a suitable testing program to ensure system reliability and to substantiate lifetime claims.
- E. The sole use of IESNA LM-80 data to predict luminaire lifetime is not acceptable.
- F. At time of manufacture, electrical and light technical properties shall be recorded for each luminaire. At a minimum, this should include lumen output, CCT, and CRI. Each luminaire shall utilize a unique serial numbering scheme. Technical properties must be made available for a minimum of 5 years after the date of manufacture.
- G. Luminaires shall be provided with a minimum 5 year warranty covering, LEDs, drivers and paint finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Minimum Color temperature for LED fixtures: 4000-4200K.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- G. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least [0.125 inch (3.175 mm)] minimum unless otherwise indicated.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.

2.3 DRIVERS FOR LED FIXTURES

- A. Electronic Driver for LED Fixtures: Comply with UL 1310 Class 2 requirements for dry and damp locations. Include the following features unless otherwise indicated:
 - 1. Rated for 50,000 hours of life, unless otherwise noted.
 - 2. Sound Rating: Class A.
 - 3. Total Harmonic Distortion Rating: 15 percent or less.
 - 4. Current Crest Factor: 1.5 or less.
 - 5. 0-10V Dimming Standard (Step Dimming does not qualify)

2.4 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: Fluorescent, two for each fixture, 20,000 hours of rated lamp life.
 - 2. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
 - 3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.5 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches

deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of [15] <Insert period> minutes when power is restored after an outage.

2.6 LED FIXTURES

- A. Interior Recessed Lights: Lithonia 2VTL4.
 1. “Lithonia” interior LED lighting is a **Board of Trustees Approved Sole Source Item**. No substitutions will be accepted.
- B. Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.
- C. Include the following features unless otherwise indicated:
 1. Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
 2. Each luminaire shall be rated for a minimum operational life of 50,000 hours utilizing a minimum ambient temperature of (25°C).
 3. Light Emitting Diodes tested under LM-80 Standards for a minimum of 12,000 hours.
 4. Color Rendering Index (CRI) of 82 at a minimum.
 5. Color temperature 4000K, unless otherwise indicated.
 6. Rated lumen maintenance at 70% lumen output for 50,000 hours, unless otherwise indicated.
 7. Fixture efficacy of 60 Lumens/Watt, minimum.
 8. 5 year luminaire warranty, minimum.
 9. Photometry must comply with IESNA LM-79.
 10. The individual LEDs shall be constructed such that a catastrophic loss of the failure of one LED will not result in the loss of the entire luminaire.
 11. Luminaire shall be constructed such that LED modules may be replaced or repaired without the replacement of the whole fixture.
- D. Technical Requirements
 1. Luminaire shall have a minimum efficacy of 60 lumens per watt. The luminaire shall not consume power in the off state.
 2. Operation Voltage: The luminaire shall operate from a 50 HZ to 60 HZ AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
 3. Power Factor: The luminaire shall have a power factor of 0.9 or greater.
 4. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 15 percent.
 5. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.
- E. Thermal Management
 1. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
 2. The LED manufacturer’s maximum thermal pad temperature for the expected life shall not be exceeded.
 3. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
 4. The luminaire shall have a minimum heat sink surface such that LED manufacturer’s maximum junction temperature is not exceeded at maximum rated ambient temperature.



2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Comply with NFPA 70 for minimum fixture supports.
- C. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
- D. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 51 00



**SECTION 26 56 00
EXTERIOR LIGHTING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Exterior luminaires with lamps and ballasts.
 - 2. Luminaire-mounted photoelectric relays.
 - 3. Poles and accessories.
 - 4. Luminaire lowering devices.
- B. Related Sections:
 - 1. Section 26 51 00 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.
 - 2. Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables".

1.3 DEFINITIONS

- A. AASHTO: American Association of State Highway and Transportation Officials
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. HID: High-intensity discharge.
- E. IESNA: Illuminating Engineering Society of North America
- F. LER: Luminaire efficacy rating.
- G. Luminaire: Complete lighting fixture, including ballast housing if provided.
- H. Pole: Luminaire support structure, including tower used for large area illumination.
- I. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
- B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4-M.
- C. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.
- D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
 - 1. Basic wind speed for calculating wind load for poles exceeding 49.2 feet (15 m) in height is **[100 mph (45 m/s)] [90 mph (40 m/s)]**
 - a. Wind Importance Factor: **[1.0]** .
 - b. Minimum Design Life: **[50 years]**
 - c. Velocity Conversion Factors: **[1.0]**.
 - 2. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is **[100 mph (45 m/s)] [90 mph (40 m/s)] <Insert value from AASHTO LTS-4-M for this Project>**.
 - a. Wind Importance Factor: **[1.0]**
 - b. Minimum Design Life: **[25 years]**
 - c. Velocity Conversion Factors: **[1.0]**.

1.5 ACTION SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation indicated on Contract Documents. Include data on features, accessories, finishes, and the following:
1. Manufacturer's dimensioned scale drawings showing in complete detail the fabrication of all lighting fixtures including overall dimensions, finishes, metal thickness, glass thickness, type, fabrication methods, support method, ballasts, transformers, sockets, type of shielding, reflectors, trims, hinges, gaskets, provisions for relamping and all other information to show compliance with contract documents.
 2. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
 3. Details of attaching luminaires and accessories.
 4. Details of installation and construction.
 5. Luminaire materials.
 6. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories. Photometric data shall be developed according to methods of IESNA.
 - a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 - b. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 7. Photoelectric relays.
 8. Ballasts, including energy-efficiency data.
 9. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
 10. Materials, dimensions, and finishes of poles.
 11. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
 12. Anchor bolts for poles.
 13. Manufactured pole foundations.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
 3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
 4. Wiring Diagrams: For power, signal, and control wiring.
 5. For outdoor pathway, parking and roadway luminaires submit photometric calculations with point by point summary layout plan. isocandela charts, coefficients of utilization and IES roadway distribution classification.
 6. Maintenance and operating instructions including tools required, types of cleaners to be used, replacement parts and final as-built shop drawings and name of the project, Architect and Lighting Consultant.
- C. Samples: For products designated for sample submission in the Exterior Lighting Device Schedule. Each Sample shall include lamps and ballasts.
- D. Fixtures under the contract shall be identical with the approved sample fixture. No fixture used as a sample shall be allowed to be installed on the project.
- E. In the event the submission are disapproved, the fixtures shall be returned to the contractor to immediately make a new submission of the fixture in compliance with the contract documents at no additional cost to the owner.
- F. All charges for these shipments shall be prepaid by the contractor.



1.6 INFORMATIONAL SUBMITTALS

- A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.
- B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.
- C. Field quality-control reports.
- D. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For [luminaires][and poles] [luminaire lowering devices] to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: [One for every 100] of each type and rating installed. Furnish at least two (2) of each type.
 - 2. Glass and Plastic Lenses, Covers, and Other Optical Parts: [One for every 100] of each type and rating installed. Furnish at least two (2) of each type.
 - 3. Ballasts: [One for every 100] of each type and rating installed. Furnish at least two (2) of each type.
 - 4. Globes and Guards: [One for every 20] of each type and rating installed. Furnish at least two (2) of each type.

1.9 QUALITY ASSURANCE

- A. Materials and appurtenances as well as workmanship provided under this section shall conform to highest commercial standards, and as specified and as indicated on drawings. Fixture parts and components not specifically identified or indicates shall be made of materials most appropriate to their use or function and as such resistant to corrosion and thermal and mechanical stresses encountered in the normal application and function of the fixtures.
- B. All fixtures shall be manufactured to a consistent level of quality. Size, color and component shall be identical for all fixtures of same types.
- C. All fixtures and components shall be made in accordance with applicable codes and standards such as NEC, CEC and bear the label of independent laboratories such as Underwriters Laboratories (UL) or Factory Mutual (FM).
- D. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- E. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.
- F. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Comply with IEEE C2, "National Electrical Safety Code."
- H. Comply with NFPA 70.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.



- B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch (6 mm) deep. Do not apply tools to section of pole to be installed below ground line.
- D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
- E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Luminaires: **[Five]** years from date of Substantial Completion.
 - 2. Warranty Period for Metal Corrosion: **[Five]** years from date of Substantial Completion.
 - 3. Warranty Period for Color Retention: **[Five]** years from date of Substantial Completion.
 - 4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than **[five]** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, **provide product indicated on Drawings and/or specifications.**

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires for external pole light application: Quadro H2 LED by Selux Corp.
- B. Luminaires for external pole light for street and roadway illumination: Cree LEDWAY series: STR-LWY.
- C. Luminaires for external wall pack application: Impact Elite LED Cylinder ISC by McGraw Edison.
- D. The light fixtures listed above are Board of Trustees Approved Sole Source Items. No substitutions will be accepted
- E. Minimum Color temperature for LED fixtures: 4000-4200K.
- F. Luminaires shall comply with UL 1598 and be UL listed and labeled for installation in wet locations.
- G. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- H. Metal Parts: Free of burrs and sharp corners and edges.
- I. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- J. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- K. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- L. Exposed Hardware Material: Stainless steel.



- M. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- N. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- O. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- P. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- Q. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- R. Factory-Applied Finish for Steel luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected from manufacturer's standard catalog of colors.
 - b. Color: Match Architect's sample of **[manufacturer's standard] [custom]** color.
 - c. Color: As selected by Architect from manufacturer's full range.
- S. Factory-Applied Finish for Aluminum luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 - 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - a. Color: **[Light bronze] [Medium bronze] [Dark bronze] [Black]**.
- T. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp and ballast characteristics:
 - a. "USES ONLY" and include specific lamp type.
 - b. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
 - d. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
 - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
 - f. CCT and CRI for all luminaires.



2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. Comply with UL 773 or UL 773A.
- B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay. **[Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.]**
 - 1. Relay with locking-type receptacle shall comply with ANSI C136.10.
 - 2. Adjustable window slide for adjusting on-off set points.

2.4 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4-M.
 - 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
 - 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of **[1.1] <Insert number>** to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - 1. Materials: Shall not cause galvanic action at contact points.
 - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
 - 3. Anchor-Bolt Template: Plywood or steel.
- D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with gasketed cover secured by stainless-steel captive screws
- E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "Cast-in-Place Concrete."
- F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
- G. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

2.5 STEEL POLES

- A. Not permitted

2.6 ALUMINUM POLES

- A. Luminaires for external pole light application: Quadro H2 LED by Selux Corp
- B. Luminaires for external pole light for street and roadway illumination: Cree LEDWAY series: STR-LWY.
- C. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.
- D. Poles: ASTM B 209 (ASTM B 209M), 5052-H34 marine sheet alloy with access handhole in pole wall.
 - 1. Shape: **[Round, tapered] [Round, straight] [Square, tapered] [Square, straight]**.
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- E. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.



- F. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- G. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
 - 1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
 - 2. Finish: Same as **[pole]** **[luminaire]**.
- H. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- I. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 - 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - a. Color: **[Light bronze]** **[Medium bronze]** **[Dark bronze]** **[Black]** **[As selected by Architect from manufacturer's full range]**.

2.7 POLE ACCESSORIES

- A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Section 26 27 26 "Wiring Devices" for ground-fault circuit-interrupter type.
 - 1. **[Recessed]**, **36 inches** above finished grade.
 - 2. Nonmetallic polycarbonate plastic or reinforced fiberglass, weatherproof in use, cover, that when mounted results in NEMA 250, **[Type 3R]** **[Type 4X]** enclosure.
 - 3. With cord opening.
 - 4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.
- B. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.
- C. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.
- D. Transformer Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and accept **[ballast(s)]** **[indicated accessories]**.
- E. Decorative accessories, supplied by decorative pole manufacturer, include the following:
 - 1. Banner Arms:
 - 2. Flag Holders:
 - 3. Ladder Rests:

2.8 LOWERING SYSTEM FOR LUMINAIRES

- A. Arrange system to lower luminaire **[assembly]** to a servicing position within 36 inches (900 mm) of finished grade in winds up to 30 mph (49 km/h) and to provide for manual plug connection to electrical power in the lowered position for testing.
- B. Coordinate with luminaire and pole manufacturers for assembly details, wind-load and vibration analysis, and compatibility of materials for electrolysis-free attachment and connection for luminaire mounting assembly, lowering device, lowering cable, and portable winch.
- C. Structural and Mechanical Design: Use a minimum safety factor of 5.0 for static and dynamic loads of load-bearing components, including cable.

- D. Luminaire Mounting and Disconnect Arrangement: Multiple [ring] [carriage]-mounted luminaires, arranged for lowering and rising as a group.
 - 1. Electrical cable for normal operating power to luminaires manually disconnects inside pole base, using weatherproof multipin connector, and shall be arranged to move within the pole during lowering and rising of luminaire assembly.
 - 2. Electrical cable for normal operating power to luminaires automatically disconnects at a weatherproof multipin connector within the pole-top lowering head at the beginning of the lowering cycle and reconnects when luminaire or luminaire assembly is raised to the operating position.
- E. Lowering Device: Weatherproof, cast-aluminum housing and multiple mechanical latches. Moving parts of latching assembly shall be located in the portion of the unit that is lowered to the servicing position. Positive latching in the operating position shall be indicated to the operator at the base of the pole by a clear visual signal, or by other means acceptable to Owner or authorities having jurisdiction.
- F. Lowering Cable: [Zinc-electroplated-] [or] [stainless-]steel aircraft cable.
- G. Portable Winch: [Manual] [120-V electric] type. [One] required.
 - 1. Winch Power Connection: Cord and plug.
 - 2. Winch Raise-Lower Control: Remote-control station with [15 feet (5 m)] of cable.
- H. Winch Transformer: Portable, totally enclosed, encapsulated, single-phase, dry type. Primary rated at lighting-circuit voltage; secondary rated at 120 V. Permanent, primary and secondary, twist-locking plug connectors on pigtails shall match pole-base power outlet and winch plug.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming

3.2 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
 - 1. Fire Hydrants and Storm Drainage Piping: [60 inches (1520 mm)] .
 - 2. Water, Gas, Electric, Communication, and Sewer Lines: [10 feet (3 m)]
 - 3. Trees: [15 feet (5 m)] from tree trunk.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
 - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
 - 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 - 3. Install base covers unless otherwise indicated.
 - 4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.



1. Dig holes large enough to permit use of tampers in the full depth of hole.
 2. Backfill in 6-inch (150-mm) layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
- F. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
1. Make holes 6 inches (150 mm) in diameter larger than pole diameter.
 2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi (20 MPa) at 28 days, and finish in a dome above finished grade.
 3. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
 4. Cure concrete a minimum of 72 hours before performing work on pole.
- G. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with [pea gravel] <Insert material> to a level 1 inch (25 mm) below top of concrete slab.
- H. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

- A. Align units for optimum directional alignment of light distribution.
- B. Install on concrete base with top [4 inches (100 mm)] above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03 30 00 "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Install on concrete base with top [4 inches (100 mm)] above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03 30 00 "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 26 05 33 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

- A. Ground metal poles and support structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
 1. Install grounding electrode for each pole unless otherwise indicated.
 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
 1. Install grounding electrode for each pole.
 2. Install grounding conductor and conductor protector.
 3. Ground metallic components of pole accessories and foundations.

3.7 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
 1. Verify operation of photoelectric controls.



C. Illumination Tests:

1. Measure light intensities at night. Tests shall be witnessed by Architect and/or Owner's representative. Provide two (2) weeks advance notice. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting Installations."
 - b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
 - c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
 - d. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - e. IESNA LM-72, "Directional Positioning of Photometric Data."
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.8 DEMONSTRATION

- A. **[Engage a factory-authorized service representative to train]** Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices.

END OF SECTION 26 56 00



SECTION 27 10 00
COMMUNICATIONS CABLING

PART 1 - GENERAL

1.1 GENERAL INTRODUCTION

- A. The work shall consist of the design, provision, termination, testing and documentation of a complete and fully functional structured high-performance copper and optical fiber communications cabling system. The instructions in this section are specific to communications installations and should be read in conjunction with other contract documents as applicable.

1.2 DEFINITIONS

- A. Throughout this specification, the following definitions will apply:
1. Provide: Supply, furnish, deliver, install, pull, fix, dress, terminate, label, test, ground and document the components as per these specifications.
 2. BDF (Building Distribution Frame) Rooms, are special-purpose rooms that provide space and maintain a suitable operating environment for the termination of backbone and campus cabling and house centralized communications and/ or computer equipment (such as Core Switches and Servers).
 3. IDF (Intermediate Distribution Frame), or Tele/Data Rooms are floor-serving spaces that provide a connection point between backbone and horizontal distribution pathways.
 4. Intra-building Backbone Cables: Cables linking the BDF and the IDF.
 5. Horizontal Cables: Cables linking the IDF to each workstation outlet.
 6. Interbuilding Backbone Cables: Cables that link the building to external connection point(s) and/or other building(s). These cables are Outside Plant (OSP).
 7. Client: Mira Costa Community College District
 8. Architect: Per project
 9. Consultant: Project consultant
 10. Bidder: A company invited to bid for the works
 11. Installer/Contractor: The Company installing the equipment as defined in this specification
 12. Construction Manager / Owner's Representative

1.3 MANUFACTURER'S COMPLETE SYSTEMS

- A. The cabling system specified in this document shall be an end-to-end solution that is sourced from a single manufacturer or partnered manufacturers. Unless explicitly noted within these specifications, this shall include patch panels, connectors, cables, patch cords, faceplates, and other associated components.
- B. Where it is specified that a system be provided by "manufacturer xxx or equal", a substitution of another manufacturer's products will only be considered for a complete end to end solution of equal quality, as determined by the Owner's Representative. All substitutions shall conform to the substitution requirements detailed in the specifications. In instances where these specifications do not include the statement "or equal" for a particular component or system, substitutions will not be entertained.

1.4 JOB CONDITIONS

- A. Prior to bidding visit the site and determine all existing conditions affecting work. The Bidder shall examine all drawings and specifications to familiarize themselves with the type of construction to be used, and the nature and extent of work provided by other trades.
- B. Verify dimensions and the correct location of hardware before proceeding with the installation of hardware, cabling and/or connections.
- C. Notify the Owners' Representative in writing immediately upon discovery of dimensional discrepancies and other conditions detrimental to proper performance of the Work.



1.5 PERSONNEL

- A. The personnel who will be employed on the contract shall be suitably trained in the management of a project of this nature and/or in the installation and maintenance of products of the type being provided to be able to carry out all work in a competent manner.
- B. The Installer shall provide a site manager responsible for all site-related issues. This individual shall be the single point of contact for the project team and shall carry a mobile phone so they can be contacted during the working hours of the project.
- C. The Installer shall be certified by the component manufacturer(s) in the installation and testing of the cabling system and shall be able to provide a manufacturers' extended performance warranty for the 'end to end' cabling system.

1.6 LABELING AND NUMBERING SCHEME

- A. Labeling of the cabling system shall be in accordance with ANSI/TIA 606-D for the Administration Standard for Telecommunications Infrastructure for Commercial Buildings. Refer to section 3.4.S of this document for specific information.

1.7 WARRANTY

- A. Installer to provide a warranty for one year from Notice of Completion on all materials and workmanship installed or supplied as part of the cabling system.
- B. The Installer shall also supply an extended performance warranty (25-year end-to-end), as offered by the components' manufacturer(s).

1.8 QUALITY

- A. The Contractor shall be responsible for the complete provision and installation of all components as specified herein. The Contractor shall provide all tools, equipment, fixtures, appliances, ancillary piece parts and hardware as necessary to complete the assembly and installation as required. The Owner's Representative may conduct scheduled or unscheduled inspections of the Contractor's work at any time during construction. All work included in the scope assigned to the contractor that is associated with this project shall be accomplished in a workmanlike manner, installed, and assembled plumb, level, and square. The product shall be delivered to the Owner finished, complete, and ready to operate according to the manufacturer's specifications.
- B. All installation work shall be completed to the standard of the samples approved by the Owners Representative during the submittal process. Any products not installed to the quality detailed in these specifications and approved in the submittal process shall be reworked by the Installer to the satisfaction of the Owner's Representative at no additional cost to the Owner.

1.9 STANDARDS

- A. All materials provided by the Installer shall meet the requirements of the following where applicable:
 - 1. National Electrical Manufacturer's Association (NEMA)
 - 2. American National Standards Institute (ANSI)
 - 3. Underwriters Laboratories, Inc. (UL)
 - 4. ETL
- B. All products, services and documentation provided by the Installer shall meet the requirements of the following where applicable:
 - 1. National Electrical Code (NEC)
 - 2. Relevant State Electric and Fire Codes
 - 3. ANSI/TIA 568.1-E Commercial Building Telecommunications Wiring Standard
 - 4. ANSI/TIA 569-E Commercial Building Standard for Telecommunications Pathways and Spaces
 - 5. ANSI/TIA 606-D The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 - 6. ANSI/TIA 607-D Commercial Building Grounding and Bonding Requirements for Telecommunications

7. Building Industry Consulting Service International (BICSI) publications:
 - a. Information Technology Systems Installation Methods Manual (ITSIMM), 7th Edition
 - b. Telecommunications Distribution Methods Manual (TDMM), 14th Edition
 - c. Outside Plant Design Reference Manual (OSPDRM), 6th Edition
8. Manufacturer's recommendations and installation guidelines including but not limited to:
 - a. Belden CSV Installation Guidelines
 - b. Chatsworth (CPI) Installation Guidelines
 - c. 3M Installation Guidelines
 - d. Sumitomo Guidelines

C. All publications referred to in this document shall be the latest edition.

1.10 SUBMITTALS

- A. All submittals shall be sent to the Construction Manager / Owner's Representative for initial processing and distribution. Three copies of each submittal should be provided unless otherwise noted. Each submittal should be provided no later than six weeks prior to the work associated with that submittal to allow time for submittal review.
- B. Project References
 1. Submit for approval, references for a minimum of three similar projects successfully undertaken and completed within the last three years. These projects should be a similar scale, complexity and have similar time scales as this project.
 2. Provide project name and address, client contact name and telephone number and construction manager name and telephone number. Provide a brief description of each project indicating types of system installed, quantities and configurations of outlets and project time scales.
 3. At least two of the references shall be in Southern California and shall be available for the Owners Representative and other members of the Design Team to visit and inspect the installation, should, in the opinion of the Owners Representative, this be necessary.
 4. These references are intended to show that the Installer has successfully completed similar projects. Failure to produce satisfactory references may result in the bid being deemed non-compliant.
- C. Personnel Training
 1. Submit for approval records regarding the management, installation, and testing personnel. These records shall include resumes, training certificates, previous work experience details (especially on reference projects) and other relevant information.
 2. Submit records to confirm that the personnel who will be employed in an installation capacity are suitably trained in the installation and maintenance of equipment and systems of the type being provided.
 3. Submit records to confirm that the personnel that will be responsible for testing the system are suitably trained in the operation of the test equipment being used in this project.
 4. These records are required to ensure that the Installer is able to carry out all work in a competent manner. Failure to produce satisfactory training documentation may result in the bid being deemed non-compliant.
- D. Cabling Diagram
 1. Submit, for approval, a complete cabling diagram. The diagram shall be based on the single line drawing included in the Construction Documents. It shall be updated to show quantities and part numbers for all components including patch panels, cable, conduit, cabinets and equipment racks, splices, splice cases and all other associated components.
- E. Test Equipment
 1. Submit, for approval, details of each item of test equipment to be used to test the optical fiber and copper components. Include patch cords and other specialized components.
- F. Product Literature/Data Sheets

1. Submit for approval manufacturer's product data sheets for each component of the telephone and data cabling systems. Certify that the data sheets depict the components to be provided by the Installer to make up the complete system as described in this specification.
- G. Component Samples and Mock-ups
 1. Provide one full size installation sample mock-up of a normal wall faceplate for approval. All samples are to be fully labeled as per these specifications. Samples are to be delivered to the Construction Manager's office on site prior to installation.
 2. All sample mock-ups are intended to represent the components that are to be installed as part of this project; therefore, they are to be provided with all associated components and labeling necessary to make up a complete mock-up. Installation shall not proceed until the Owner's Representative has approved the samples. Once samples and other documents have been submitted, inspected by the Owners' Representative, and approved, they shall be retained. The samples will be used as the standards by which the quality of work on the project by the Installer shall be judged. Any installation that does not meet this standard shall be replaced or re-worked as approved by the Owners' Representative, at no cost to the project.
- H. As-Built Documentation (required upon completion of the work)
 1. Following completion of the installation, submit the following record drawings, documentation, and testing for approval.
 2. As-Built Drawings
 - a. As-built drawings showing locations of telephone, Technology Rooms and data outlets, backbone, link and external cable routes, data rack locations, telephone termination board locations and station identification.
 - b. Provide 24" x 36" laminated copies of as-builts mounted to the wall in each Technology Room.
 3. Final Test Results
 - a. Test results for each copper and fiber cable indicating tests performed, results obtained, and values measured. All cables must meet or exceed applicable ANSI/TIA standards and qualify for the manufacturer's warranty. Refer to section 3.7 of this document for testing requirements.
 4. All documentation and drawings shall be provided in an un-locked, editable PDF as well as the project BIM model in use at project completion or composited CAD (.DWG) files based on project preference. Schedules shall be provided in MS EXCEL, and all test results shall be provided in both PDF and the tester manufacturers' native test file format. All documentation shall be provided in electronic format, and (3) hard copies.

PART 2 - PRODUCTS

2.1 HORIZONTAL COPPER CABLING

- A. Provide Belden REVConnect 3600 series, or approved equal from Siemon or CommScope Systimax, Category 6 UTP Cable. Each cable shall have four pairs of unshielded twisted-pair solid copper conductors. The cable shall be rated for the environment in which it is installed (CMP or CMR). Each cable shall meet or exceed the performance specifications in this document when installed as part of the end-to-end cabling system described in this specification.
- B. The high-performance copper cabling system shall meet or exceed the performance specifications for Category 6 cabling as detailed in ANSI/TIA 568.1-E. This covers all Category 6 components installed as a part of the installation. Cables shall be black.
- C. Wireless Access Points: Provide Belden 10GXS or 10GXW series, or approved equal from Siemon or Commscope Systimax, Category 6A UTP Cable. Each cable shall have four pairs of unshielded twisted-pair solid copper conductors. The cable shall be rated for the environment in which it is installed (CMP or CMR). Each cable shall meet or exceed the performance specifications in this document when installed as part of the end-to-end cabling system described in this specification.
 1. The copper cabling system shall meet or exceed the performance specifications for Category 6A cabling as detailed in EIA/TIA 568.1-E This covers all Category 6A components installed as a part of the installation.
 2. Wireless Access Point copper cables shall be black in color.

3. Each Wireless Access Point shall receive (2) Category 6A cables, per TIA-568.0-E
- D. Outside plant cables or cables run in conduits beneath the vapor barrier of a slab-on-grade must be rated indoor / outdoor and contain water-blocking agents and be rated for all environments for which they are installed.

2.2 OPTICAL FIBER CABLES

- A. All site fiber is Sumitomo FutureFlex Air Blown Fiber in Sumitomo indoor or outdoor tube cable (Sole Source).
- B. Where Sumitomo FutureFlex cannot be installed (in existing occupied conduits or pathways) a tight-buffered indoor / outdoor OS2 tight buffered optical fibers within a dry water blocked cable core. Confirm with District ITS prior to using non-Sumitomo fiber optic cable.
- C. Singlemode Cable (OS2) Elements shall conform to the following specification:
 1. 8.3 micron core diameter, 125 micron cladding diameter (+/- 1 micron)
 2. Mode field diameter of between 8.7 and 9.3 (with +/- 0.5 micron tolerance) at 1310 nm
 3. Attenuation coefficient at 1310 nm of 1.0 db/km or less
 4. Attenuation coefficient at 1550 nm of 1.0 db/km or less
 5. Cladding non-circularity of +/- 1%
 6. Core to cladding concentricity error of no more than 0.8 micron.
 7. Maximum dispersion rate of 2.80 ps/nm-km at 1300 nm
 8. Maximum dispersion rate of 17.00 ps/nm-km at 1550 nm
 9. Individual glass elements proof tested at 100 kpsi (100,000 lbs. per square inch)
 10. Number of elements as indicated on the drawings.

2.3 WORK AREA CONNECTORS

- A. Provide Belden REVConnect PS6+ or approved equal from Siemon or Commscope Systimax to match cabling manufacturer for compliance with the end-to-end system warranty, eight-position modular RJ45 jacks. Each connector shall meet or exceed the channel performance specifications in this document when installed as part of the end-to-end cabling system described in this specification. The pin outs for the jack shall conform to the T568B wiring scheme.
- B. Work area connectors shall be blue for all communications ports.
- C. Refer to project drawings for work area outlet types and quantity of ports for each type.

2.4 PATCH PANELS

- A. Copper Patch Panels: Provide Belden REVConnect Cat 6+ / REVConnect 10GX Cat 6A, or approved equal from Siemon or CommScope Systimax to match cabling manufacturer for compliance with the end-to-end system warranty. Patch Panels conforming to the following specification:
 1. Suitable for mounting in standard EIA 19" racks.
 2. Configured with 48 jacks housed in each 2U (3.5") of usable rack space.
 3. Provide strain relief for each cable terminated on the connector at the rear of the patch panel.
 4. Allow for labeling of each individual connector.
 5. Allow any individual cable to be terminated or otherwise handled without disturbing other cables.
- B. Rack Mounted Optical Fiber Patch Panel. Provide Sumitomo PrecisionFlex optical fiber patch panel, conforming to the following specification:
 1. Each panel shall be suitable for installation in TIA 19" mounting frame.
 2. Configured with 72 connectors housed in each 1U of usable rack space.
 3. Allow for labeling of each individual connector.
 4. Allow any individual cable to be terminated or otherwise handled without disturbing other cables.
 5. Each panel shall provide fiber handling for fiber elements, including 36" fiber reserve (service loop) inside the patch panel with no bends sharper than 2" bend radius.
 6. Provide blanking adapter plates to cover all unused spaces as necessary.
 7. Sumitomo Interconnect Panels, singlemode 12-fibers (LC duplex)

8. Sumitomo Field Breakout Kit
 9. Sumitomo Blank Adapter Panel
- C. Provide 25% additional capacity in patch panels.

2.5 OPTICAL FIBER CONNECTORS –

- A. Singlemode Optical Fiber Connectors. Provide fusion-spliced factory manufactured pigtails, no equal, LC optical fiber connectors, conforming to the following specification.
1. Duplex, handling one pair (two elements) per connector.
 2. Blue in color.
 3. Available in both 900 micron buffered strands and 250 micron loose tube strands.
 4. Maximum insertion loss, of mated pair, less than 0.5 dB at acceptance.
 5. Minimum return loss of greater than or equal to 50 dB.
 6. Durability better than 500 matings, with a maximum increase in insertion loss of not more than 0.2 dB.
 7. Meets ANSI/TIA 568.3-E and ISO 11801 standards.

2.6 PATCH CORDS

- A. Copper: Provide two high performance copper patch cords per telecommunications cable installed. These shall be sourced from the same manufacturer as the connectors provided as a part of this project. Each cord shall meet or exceed the performance specifications in this document when installed as part of the end-to-end cabling system described in this specification.
1. 30% of the patch cords shall be 1 foot in length.
 2. 10% of the patch cords shall be 2 feet in length.
 3. 20% of the patch cords shall be 7 feet in length.
 4. 40% of the patch cords shall be 15 feet in length.
 5. Prior to purchasing ANY patch cords, confirm with client IN WRITING, exact colors, quantities and whether the patch cords shall be standard 24 AWG.
- B. Optical Fiber: Provide one optical fiber patch cord per optical fiber pair installed. These shall be sourced from the same manufacturer as the optical fiber connectors provided as a part of this project. Each cord shall meet or exceed the optical fiber performance specifications in this document.
1. 40% of the patch cords shall be 1 meter in length and yellow in color.
 2. 40% of the patch cords shall be 2 meters in length and yellow in color.
 3. 20% of the patch cords shall be 3 meters in length and yellow in color.
- C. Contractor to coordinate with MCC IT Department for exact colors, lengths and quantities prior to purchase.
- D. The patch cords are to be passed to the client on completion of the project. Each cord is to have a manufacturer's certificate of conformance and shall be in its original, unopened packaging.

2.7 WORK AREA FACEPLATES

- A. Wall-mounted Faceplate. Provide Belden MediaFlex (P/N: AX101747) or approved equal from Siemon or CommScope Systimax to match cabling manufacturer for compliance with the end-to-end system warranty, wall-mounted flush stainless steel modular faceplate to house work area jacks, capable of housing a minimum of four jacks. The faceplate shall fit over a standard NEMA electrical outlet box fitted with a single gang plaster ring cover and shall be office white in color.
- B. Blanking Inserts. Provide blanking inserts, matching faceplates, in sufficient quantities to cover all unused openings in every faceplate.
- C. Wallphone Faceplate. Provide a Belden MediaFlex or approved equal from Siemon or CommScope Systimax to match cabling manufacturer for compliance with the end-to-end system warranty, wall-mounted flush stainless steel modular faceplate to house a single work area jack. The faceplate shall fit over a standard NEMA electrical outlet box fitted with a single gang plaster ring cover. The faceplate shall be capable of having a wall-mounted telephone fitted directly over it.



- D. Furniture Faceplate. Provide a Belden MediaFlex or approved equal from Siemon or CommScope Systemax to match cabling manufacturer for compliance with the end-to-end system warranty, flush-mounted modular faceplate to house work area jacks. The faceplate shall fit over a modular raceway.
- E. Floor Box (or Poke-Through) Faceplate. Provide an internal blank bracket to house combinations of work area connectors in a flush-mounted floor box. The bracket shall be provided by the manufacturer of the flush floor box and shall be designed to fit in the floor box installed as a part of this project. The faceplate shall be similar to the wall mounted stainless steel faceplate or per floor unit metal (powder-coated) plate to fit within the enclosure. Refer to Section 2.8 for additional combination multi-service floor box and poke-through information.
- F. JACE panels. At all JACE HVAC control panels, provide (1) Cat 6 cable terminated on a surface mounted box, adjacent to, or inside equipment enclosure. Coordinate with HVAC contractor for final termination location.

2.8 FLOOR BOXES

- A. Power/Data Floor Boxes
 1. Provide Legrand Wiremold RFB2 two-compartment recessed floor box for power and data services.
 2. Include flush lid configured with color and trim material coordinated with the project architect for matching aesthetics.
 3. Contractor shall coordinate box sizing with Campus Media prior to ordering.
 4. Contractor shall ensure that floor box is suitable for the environment in which it is being installed.
- B. Multi-service Floor Boxes Power/Data/AV Poke-Through
 1. Provide FSR, Inc. FL-500P-6 6" deep floor box and pour-pan (as required) with multiple bays for services or equivalent from Legrand Wiremold. Separate high-voltage and low-voltage services maintaining data and Audiovisual together on one side or floor box and power on the opposite side. Data and Audiovisual conduits to be separate for dedicated services cabling.
 2. Include flush lid configured for carpet/tile insert or solid surface with color and trim material coordinated with the project architect for matching aesthetics.
 3. Contractor shall coordinate box sizing with Campus Media prior to ordering.
 4. Contractor shall ensure that floor box is suitable for the environment in which it is being installed.
- C. Multi-service Floor Boxes Power/Data/AV Poke-Through
 1. Provide FSR, Inc. PWB-100 recessed in-wall enclosure behind displays with multiple bays for services. Separate high-voltage and low-voltage services maintaining data and Audiovisual together on the top side or wall box and power on the lower side. Data and Audiovisual conduits to be separate for dedicated services cabling.
 2. Include white cover plate and prime/paint as required to match the wall finish schedule in coordination with the project architect for matching aesthetics.
 3. Contractor shall coordinate box sizing with Campus Media prior to ordering.
 4. Contractor shall ensure that floor box is suitable for the environment in which it is being installed.

2.9 LABELS

- A. Provide labels for connectors, cables, outlets, termination frames and patch panels.
- B. The lettering on each label shall be as large as is practicable. All labels shall be machine-produced. Hand-written labels will not be acceptable.
- C. A standard relative orientation shall be adopted for all labels unless otherwise specified.
- D. Labels shall be robust, durable, shall resist abrasion and shall be UV inhibiting, permanent and indelible. Labels shall be proof to 140 degrees Fahrenheit.
- E. All labels shall be readily visible and shall be fixed so that they remain in a visible position wherever practical.



- F. Labels shall carry the full complement of characters to designate the unique identifications for the item that they identify.
- G. The faceplate labels are to be a white and black laser or thermal printed label, i.e. black letters on a white background. Labels are to be placed below the clear plastic lens on the face plate.
- H. The patch panel labels are to be a white and black adhesive-backed nylon thermal printed labels, i.e. black letters on white background. Labels are to be placed below the clear plastic lens on the face plate.
- I. The Patch Panel labels shall be permanently fixed to the patch panel front cover with an epoxy adhesive.

J. Cable Labels

- 1. Provide self-laminating wrap labels for cables with less than 1/2" diameter. The labels shall be permanently fixed to each cable once they have been installed. Any labels that split, partially split or otherwise damaged shall be replaced.
- 2. Horizontal Cabling: Label each cable so that the label is within 8" of the end of the cable at the patch frame end and within 6" of the end of the cable at the outlet end.
- 3. Refer to section 3.4.S for labelling scheme.

2.10 EQUIPMENT RACKS

- A. Floor Mounted: Provide CPI 46353-E03, no equal, as shown on the Drawings. Each rack shall conform to the following specification:
 - 1. Each rack shall consist of a modular EIA 19" mounting frame, with a minimum of 84" (45U) space for equipment in the vertical plane.
 - 2. Provide all mounting components and accessories to securely fix racks to floor and supporting walls. Provide appropriate seismic transverse and longitudinal bracing per any local codes and the current NUSIG (National Uniform Seismic Installation Guidelines).
 - 3. Provide overhead ladder rack, CPI 10250-718, no equal, fixed to the top of each rack and running from the top of the rack to the telephone backboard where the feeder and horizontal cables run, as shown on the drawings.
 - 4. Provide cable bend management fixtures to maintain the proper bend radius as the cables drop into the rack. Do not allow cables to be unsupported as they run from conduit or cable tray to equipment cabinets.
 - 5. Provide appropriate seismic bracing brackets for anchoring the cabinets on raised floor. Use a minimum of 5/8" threaded rod and appropriate concrete drop-in anchors for securing the cabinets above on the raised floor. The 5/8" threaded rod shall be further secured with aircraft cable per any local codes and the current NUSIG (National Uniform Seismic Installation Guidelines).
 - 6. Each rack shall have a load-carrying capacity of 1000 lbs.
 - 7. Provide patch management ring runs in each rack. Provide (1) 2U front-side horizontal patch management in the top of each rack – CPI 30130-X19, no equal. Provide two-sided CCS type vertical cable management with hinged doors on both sides of each rack – CPI 30162-X03, no equal.
 - 8. Provide strain relief and cable management at the rear of each rack to ensure tidy routing of all feeder and horizontal cables.
 - 9. The rack shall be manufactured from extruded aluminum and white in color.
 - 10. Provide dedicated 120v and 208v outlets at each rack. Contractor to coordinate location, voltage, NEMA outlet configuration, and quantity of outlets with technology consultant and owner before installation, and prior to providing an uninterruptable power supply (UPS) or power distribution unit (PDU).
- B. Wall Mounted: In enclosed / protected spaces ONLY, provide CPI 11791-E25, no equal, as shown on the Drawings. Each rack shall conform to the following specification:
 - 1. Each rack shall consist of a modular EIA 19" mounting frame, with a minimum of 28" (20U) space for equipment in the vertical plane.

2. Provide all mounting components and accessories to securely fix racks to supporting walls. Provide appropriate seismic transverse and longitudinal bracing per any local codes and the current NUSIG (National Uniform Seismic Installation Guidelines).
3. Provide cable bend management fixtures to maintain the proper bend radius as the cables drop into the rack. Do not allow cables to be unsupported as they run from conduit or cable tray to equipment cabinets.
4. Provide patch management ring runs in each rack. Provide (1) 2U front-side horizontal patch management in the top of each rack – CPI 30130-X19, no equal.
5. Provide strain relief and cable management at the rear of each rack to ensure tidy routing of all feeder and horizontal cables.
6. The rack shall be manufactured from extruded aluminum and white in color.

2.11 EQUIPMENT CABINETS

- A. Provide CPI ZetaFrame Equipment Cabinets or approved equal from APC or Middle Atlantic as shown on the Drawings. Cabinet size shall be pre-approved by MCC ITS and shall conform to the following specification:
 1. Each cabinet shall house two 19" internal mounting frames. Each pair of mounting rails shall be depth adjustable for front and rear equipment support. Cabinet shall be 32" wide by 42" deep.
 2. Each cabinet shall provide a minimum of 84" (45U) space for equipment in the vertical plane.
 3. Each cabinet shall have a minimum load-carrying capacity of 2500 lbs.
 4. Provide grommets openings at the top of each cabinet requiring top access. The openings shall be a series of 4" diameter holes with bushings. The openings shall allow the cables to easily enter the cabinet and be routed into the cabinet cable management.
 5. Provide all mounting components and accessories to securely fix cabinets to floor. Provide appropriate seismic transverse and longitudinal bracing per any local codes and the current NUSIG (National Uniform Seismic Installation Guidelines).
 6. Provide cable bend management fixtures to maintain the proper bend radius as the cables drop into the cabinet. Do not allow cables to be unsupported as they run from conduit or cable tray to equipment cabinets.
 7. Each cabinet shall have a lockable perforated metal front door, lockable double perforated metal rear doors, and two solid side panels.
 8. Provide Velcro cable straps, at the front of the cabinet, to each side, to manage patch cords, every 5U on both sides of each rack.
 9. Provide cable supports, to each side, at rear to loom fixed cable terminations
 10. Provide (1) 2U front-side horizontal patch management in the top of each cabinet CPI 30130-X19, no equal. Each cabinet shall be equipped with at least one internal vertical cable manager designed for the selected system.
 11. All other parts needed to make the cabinet into a usable system shall be provided. These parts include appropriate bolts, installation kits, and mounting equipment for items specified.

2.12 INTERNAL/EXTERNAL WIRELESS ACCESS POINT

- A. Install MCC provided Wireless Access Points. Current Wireless Access Point models are Cisco C9130AXI-B and AIR-AP1262I-B-K9.
- B. Install outdoor wireless access point antenna concealment shroud.
 1. Current Wireless Access Point model to requires the associated (paintable) shield or cover for the Catalyst 9124AX, part # C9124-CVR1.
 2. Prime and paint as required to match building finish - use RF-transparent water-based paint as recommended by MFG.
- C. All model numbers must be confirmed with MCC ITS prior to ordering.

2.13 COMMUNICATION UTILITY VAULTS

- A. All utility vaults to be installed shall be specifically designed for telecommunications applications, with no exceptions.

- B. Maximum spacing between Manholes, Pull boxes, or Handholds is 450 feet.
- C. Materials
 - 1. The Contractor shall provide pre-cast utility vaults meeting ASTM C 478 with 28 day 5500 psi minimum compressive strength concrete and designed for AASHTO H-20 loading per AASHTO HB 14. See conduit construction drawings for vault sizes. The Contractor shall install vaults to meet all manufacture requirements. The contractor shall furnish and place sand bedding to allow proper weight distribution and leveling of all vaults.
 - 2. Utility vaults shall have tongue-and-groove double sealed joints on mating edges of pre- cast components. The joints shall firmly interlock adjoining components and provide waterproof junctions and adequate shear transfer. Joints shall be sealed with approved watertight joint sealant as prescribed in the manufacturer's installation specifications and conforming to AASHTO M198, Type B. Sealing material shall be installed in strict accordance with manufacturer's printed instructions.
 - 3. Conduit Entrances
 - a. For conduit installed on this project, knockout panels or pre-cast individual conduit openings may be used.
 - b. For existing utility vaults, new ducts shall enter the utility vault with factory- formed bell end of the conduit, and a seal around the conduit shall be applied after installation. Existing utility vaults that shall be re-used to install new copper and fiber cables shall be retrofitted with the required racking and grounding and bonding per the TIA Bonding and Grounding Standards.
 - 4. Covers
 - a. The Contractor shall provide solid covers (traffic rated), with a 76.2 cm (30 in.) diameter clear opening.
 - b. Heavy-duty type frames and covers made of cast iron, suitable for H-20 loading, and having machined bearing surfaces shall be used.
 - c. The covers shall be of indented type with solid top design.
 - d. The upper side of each cover shall have the letters "Communications" cast or burned by welder, in integral letters no less than 2 inches high. The ring of the casting shall be field stamped with utility vault or pull box numbers as indicated on the conduit drawings.
 - e. Double lids are required for vaults over 12 feet in length as per OSHA.
- D. Manufacturers: Jensen Precast, Associated Concrete Products, Brooks Products, & Utility Vault Company or equal.

2.14 COMMUNICATIONS PULL BOXES

- A. Pre-cast pull boxes shall meet the standards defined in Subsection 2.1.B.(1).
- B. Joints and seals shall be provided and installed as defined in Subsection 2.1.B.(2).
- C. Conduit entrances shall be provided as defined in Subsection 2.1.B.(3).
- D. Pull boxes shall be equipped with cable racking hardware suitable to support large copper cables.
- E. All pull boxes shall be equipped with traffic-rated spring-loaded hinged lids with a locking mechanism. All lids shall have the identification marking of "Communications" permanently affixed to the cover. The upper side of each cover shall have the letters "Communications" cast or burned by welder, in integral letters no less than 2 inches high. The cover shall also be field stamped with two inch high pull box identification numbers as indicated on the conduit drawings.
- F. Manufacturers: Jensen Precast, Associated Concrete Products, Brooks Products, & Utility Vault Company or equal

2.15 COMMUNICATIONS UTILITY VAULT/PULL BOX HARDWARE

- A. Materials
 - 1. Pulling irons shall be provided, as required for the size of utility vault/pull box (minimum of 4 per utility vault: 2 Installed on each end wall, top and bottom). Pulling irons shall be installed opposite the terminators. All pulling irons shall be constructed of 2.2 cm (7/8 inch) hot-dip galvanized steel.

2. A sump of 30cm (12 in.) in diameter shall be provided in each utility vault, per the manufacturer's specifications.
3. Heavyweight cable racks with adjustable arms shall be provided for all cables in each utility vault. The racks shall be attached with adjustable inserts set in the concrete walls (Bolts or studs embedded in concrete will not be used). Racks and inserts shall be centered on the side walls that are utilized for the racking of splice cases in the utility vault, arranged so that all spare conduit ends are clear for future cable installation. The racks shall have a sufficient number of arms to accommodate cables for each conduit entering or leaving the utility vault.
4. Corner standoff brackets 15cm to 20cm (6 in. to 8 in. from wall) shall be provided if the utility vault is equipped with center exit conduits. The bracket shall extend from 15cm (6 in.) off floor to 15cm (6 in.) below roof.
5. All utility vault and pull box hardware shall be steel that is hot dip galvanized after fabrication.
6. Each utility vault shall have a detachable galvanized steel ladder per opening that can be removed to facilitate future work in the utility vault. The ladder shall be secured to a top support arm in the utility vault opening or chimney.

B. Manufacturers

1. Hardware: Jensen Precast, Alhambra Foundry (model No. A-3382 ladder with A-3383 support bar), Inwesco Products, or equal.
2. Utility vault: Jensen Precast, Brooks, Utility Vault, or Associated Concrete Products, or equal.

2.16 COMMUNICATIONS DUCT-BANKS

A. Materials

1. Conduit
 - a. Schedule 40 PVC - Size and quantity as shown on Drawings.
2. Conduit shall have a factory formed bell on one end for interconnecting segments.
3. All conduits shall be installed in an encased steel pipe where a boring method is utilized. Grout shall be provided between conduits inside pipe and around steel pipe to fill voids per manufacturer's specifications.
4. Spacers: High impact spacers shall be used in all multi-duct systems, for both solely- owned or joint telecommunications/power constructions. They shall conform to NEMA TC- 2, TC-6, TC-8, and ASTM F 512 dimensions.
5. All fittings shall be designed specifically for use with the type of conduit Installed.
6. All conduits shall be equipped with expansion rubber type sealing plugs in all utility vaults/pull boxes to include conduits within all buildings.

B. Manufacturer: CARLON or equal for conduit.

TYCO / JACKMOON for conduit Duct Sealing Plugs

2.17 COMMUNICATIONS ENTRANCE CONDUIT

- A. Conduit entering a building shall be galvanized steel pipe (rigid steel). Conduit shall transition from PVC to GRC at a distance of 24 inches beyond the exterior of the foundation to two inches AFF in the entry room. The conduits shall slope downward away from the building to reduce the potential of water entering the building. All metal conduits shall be equipped with a plastic grommet to prevent cable damage during Installment.

2.18 DUCT-BANK LOCATING CABLE (DETECTABLE WARNING TAPE)

- A. Warning tape shall be a minimum of 6" wide, orange in color, and shall have a nondegradable imprint as follows:
 1. "Caution Fiber Optic Cable Buried Below"
- B. The tape shall be detectable.
- C. Manufacturer: As follows:
 1. Carlon
 - a. MAT3061 "Caution Fiber Optic Cable Buried Below".



- 2. Equivalent manufacturer's type and style is acceptable.

2.19 PULL ROPE

- A. Pull rope shall be new 3/4" polyester mule tape with a minimum 2500 lb. tensile strength.
- B. Manufacturers: NEPTCO or equal.

2.20 BONDING/GROUNDING

- A. The reinforcing steel in the walls of the utility vault shall be bonded together and brazed to the bronze inserts of each section of the utility vault per the manufacturer's utility vault specifications. The ground inserts shall be attached to the steel rebar to provide a point of attachment for the ground wires or bonding ribbon. The inserts shall be bronze, flush mounted, and brazed to the rebar cage of all the sections of the utility vault (bottom, intermediate, and roof sections).
- B. Materials
 - 1. Bonding Ribbon: Shall be made of annealed solid copper 3/8 inch wide x 1/16 inch thick, tin plated. Manufacturer: INWESCO Cat.12A55 or equal.
 - 2. Bonding Ribbon Clamp: Shall be made of soft lead 1/2 inch wide by 1/16 inch thick and shall accept 1/4 inch diameter bolt. Manufacturer: INWESCO Cat. 12A56 orequal.
 - 3. Fargo Clamp: Shall be cast from copper, silver plated, furnished with copper bolt. Manufacturer: INWESCO Cat.12A57 or equal.
 - 4. Ground Inserts: Shall be made of Cast Bronze W/1/4 Copper Rod. Manufacturer: INWESCO Cat.12H69 or equal.

2.21 CONDUIT AND RACEWAY TAGS

- A. All conduits and other raceways shall be labeled with permanent type tags. Tags shall include destination engraved onto the tag. Adhesive or taped-on type markers shall not be permitted.

2.22 EMERGENCY PHONES

- A. General Description
 - 1. The unit shall be a vandal-resistant, high quality, communications device, model LS1000 from Code Blue Corporation, no substitutions. It shall have a real time, non-open source, proprietary operating system. It shall have a single enclosure comprised of all electronics with a fixed IP color camera, serviceable speaker, microphone, button, and PCB components. MCC IT to be consulted prior to ordering and approved in writing by MCC IT representative.
- B. Construction
 - 1. The speakerphone shall measure 8.5" W x 11.75" H x 2.56" D with six screw holes and weigh approximately 4.93 lbs
 - 2. The faceplate shall be constructed of 0.104" thick stainless steel with custom-designed, vandal-resistant camera*, microphone and speaker openings.
 - 3. An 8.5" W x 11.75" H x 0.13" D rubber gasket shall be on the back of the faceplate.
 - 4. A 3.5" weatherproof speaker, camera and optional keypad shall be mounted via .50" stainless steel studs, locking washers and lock nuts.
 - 5. Aluminum stand offs and locking washers shall be utilized to mount conformal coated electronics. A molded plastic housing shall be secured with aluminum standoffs, locking washers and stainless-steel screws. Weatherproof modular connectors shall be utilized for external power, auxiliary, PAS control, communication, audio output connectivity.
- C. Product Features
 - 1. The enclosure shall be capable of using interchangeable faceplates: single button, two button, and two button with keypad.
 - 2. Self-monitoring and fault reporting for loss of power, PAS amplifier/speakers (if attached), battery voltage and button, speaker, microphone, and keypad failure. Built-in scripting language provides advanced button and diagnostic report programming.
 - 3. Operational temperature shall be -40° to +70° Celsius (-40° to +158° Fahrenheit).

PART 3 - EXECUTION

3.1 HORIZONTAL CABLING AND COMPONENTS

- A. Horizontal Station Cabling
 - 1. Provide one four-pair plenum-rated horizontal cable running from each work area connector to the patch panels located in the Technology Room serving that outlet.
 - 2. Terminate all four pairs of each end of each cable with an RJ45 communications connector using the T568B termination scheme.
 - 3. Cables shall not exceed 90 meters.
- B. Horizontal Wireless Access Point Cabling
 - 1. Provide (2) Category 6A 4-pair cables running between each of the Telecommunications Rooms.
 - 2. Terminate all four pairs of each end of each cable with a Cat 6A RJ45 communications connector fitted in a rack-mounted patch panel using the T568B termination scheme.
 - 3. Cables shall not exceed 90 meters.
- C. Work Area Outlets
 - 1. Standard Work Area Outlet. Each standard work area outlet will be a wall-mounted flush modular faceplate configured with (2) RJ45 connectors, unless otherwise noted. The faceplate shall fit over a deep NEMA electrical outlet box fitted with a single gang plaster ring cover. Any unused faceplate opening shall contain a blanking insert.
 - 2. Wall-phone Outlet. Each wall-phone outlet will be a wall-mounted flush modular faceplate to house a single (1) RJ45 connector. The faceplate shall fit over a deep NEMA electrical outlet box fitted with a single gang plaster ring cover and be capable of having a wall-mounted telephone fitted directly over it.
 - 3. Furniture / Raceway Outlet. Each Furniture outlet will be a flush-mounted modular faceplate. The faceplate shall fit over a modular raceway.
 - 4. Floorbox Outlet. Each Floorbox outlet will be a flush-mounted modular faceplate.
 - 5. Audiovisual Station Outlet. Outlets to be coordinated with MCCCDC Media Services for actual quantity by system for a one-to-one networked device correlation.

3.2 EXTERNAL CABLING AND COMPONENTS

- A. Optical Fiber Cabling
 - 1. Provide external optical fiber running from the Telecommunications Room to the Data Center. Contractor shall use existing innerduct running from the nearest Communications Manhole to the MDF. Terminate each pair of optical fiber elements with the same optical fiber connectors used for the backbone cabling system, fitted in an optical fiber rack-mounted patch panel. Label each connector with the backbone cable number.
 - 2. Provide patch panels fitted in the equipment cabinet, racks, and/or wall mounted as needed per project to house optical fiber cables terminated on optical fiber connectors.
 - 3. Securely fix all patch panels in place.
 - 4. Provide patch panels to house all specified optical fiber cables and connectors.
 - 5. Terminate all elements of each optical fiber cable with the specified connectors. Strip back the optical fiber cable jacket, providing a 36" service loop for each optical fiber element. Neatly dress these loops in the patch panel using appropriately sized spiral wrap, so they are protected.

3.3 TECHNOLOGY INFRASTRUCTURE

- A. Data system equipment cabinets and racks
 - 1. Provide equipment cabinets and racks, as shown on the drawings.
 - 2. Securely fix the cabinets/racks in place using anchors or bolts as specified by the manufacturer, SEOR, and AHJ. Details are provided in the technology drawings.
 - 3. Whenever cables are to enter the cabinets from above, provide a 12"x6" grommeted opening on the top of the cabinet.

4. Attach the power strip to the cabinet/rack. Ensure that the power strips are connecting to the cabinets/racks in such a way that the structural integrity of the cabinets/racks is not compromised. Connect the cabinet power strip to an appropriate power receptacle.
 5. Fix each cabinet and rack to the floor and supporting walls to provide stability and prevent movement of the cabinet or rack. Fix adjacent racks and cabinets together.
 6. Install the appropriate seismic transverse and longitudinal bracing per any local codes and the current NUSIG (National Uniform Seismic Installation Guidelines).
- B. Conduit, Ladder Rack And J-Hook Installation
1. Provide solid metal conduit to protect cable runs as needed. Securely fix this conduit to structural elements at regular intervals. Provide couplings, end pieces, grommets, and associated components to make up a complete conduit run. All conduit installation shall be done in accordance with the relevant NEC regulations. No L-bends (condulets) are to be installed; any bends in the conduit runs are to be provided using sweeps.
 2. Where cables are installed in an open cabling method (i.e. J-Hooks) and encounter full height partitions or other obstructions, Contractor shall provide conduit sleeves. Conduits sleeves shall be sized and fire-stopped per all applicable national and local electric and fire codes.
 3. Ladder rack. Provide metal ladder rack within Telecommunications Rooms to support equipment racks and route communications cabling. Ladder rack to be bonded together and grounded to the Telecommunication busbar within the Telecommunications Room.
 4. J-Hooks. Where conduit or cable tray is not provided to support cable runs, provide J-Hooks fastened to the structural slab at 48" centers. J-Hooks shall not be attached to beams, ceiling tile tee grid or wire hangers used to support the ceiling grid. J-Hooks shall be attached to the slab using anchors and ¼" rod used exclusively for supporting J-Hooks. J-Hooks can be fixed to stud walls provided the cable load is no more than 10lbs per stud. J-hooks shall be dedicated for telecommunications cabling and shall not be shared with cabling for other building services.
 5. Install the appropriate seismic transverse and longitudinal bracing per any local codes and the current NUSIG (National Uniform Seismic Installation Guidelines).
- C. Innerduct / Tube Cell
1. Provide tube cells to protect air blown optical fiber cable runs between buildings.
 2. Provide innerduct to protect intrabuilding conventional optical fiber cable runs. Innerduct size shall be coordinated with MCC ITS based on available space within pathway.
 3. Securely fix the innerduct to structural elements at 36" centers. Provide couplings, end pieces, grommets, and associated components to make up a complete innerduct run. The innerduct shall be a suitable fire rating for the installed environment.
- D. Communications Manholes
1. Provide a 12' service loop for each external cable that passes through a communications manhole. Dress the cable to keep it clear from any water that may be in the bottom of the manholes and to minimize any risk of damage caused by later visits to the manhole.

3.4 INSTALLATION PRACTICE

- A. Provide bushings, grommets and strain-relief for cables terminating at wall-mounted outlets and patch panels to ensure durable and robust connections. The bushings and grommets are intended to protect the cables from any sharp edges that present a risk to the cables. Ensure that all sharp edges are covered to protect the cables from damage.
- B. No cables shall be installed in a fashion that contravenes either the minimum installed or the minimum under-load bend radius of the cable.
- C. No cable is to be pulled through a conduit "L-bend" (condulets). In existing routes with L-bends, the cables are to be pulled to the L-Bend. The cable is then to be carefully pulled through the remainder of the conduit run.



- D. Install all cables in complete runs from outlet or patch panel to patch panel. In-line joints, splices, distribution points or other intermediate connections are not permitted unless specifically called out by this specification.
- E. At no point shall the communications cables be tied to power cables or other building services or their supports, or run in the same ducts, raceways, conduits or connection boxes as power cabling.
- F. Use plenum-rated Velcro tie wraps in plenum spaces.
- G. Reinstate all pull-wires in conduits and ducts after use to facilitate future addition of cables.
- H. Cables shall not be held so tightly with cable ties that the cable jackets are indented by the cable ties.
- I. Ensure that all waste materials are disposed of in a safe manner. Pay particular attention to waste materials produced during the termination of optical fiber cabling. Ensure that all used components and fiber cut-offs are collected in purpose-made containers and disposed of properly.
- J. Replace all moisture and fire barrier material in ducts, conduits and other penetrations disturbed during installation of communications cabling. Install barrier material in all fire-rated penetrations that have cabling running through them. The barrier material shall be installed so the final penetration has the same fire rating as the original wall/floor.
- K. Use purpose-built pulling grips during cable installation. Do not pull cables by attaching pull wires to cable jackets, elements, or reinforcement. Use strain gauges or equivalent measures to ensure that the maximum tensile load rating of the cables is not exceeded during installation.
- L. Provide J-hooks and cable hangers as necessary to support cables running in the ceiling void. J-hooks shall be appropriately sized to allow a minimum of 50% spare capacity for future cable installation. J-hooks shall be at least 1" wide and fitted at no more than 48" centers.
- M. The number of cables in each conduit shall be controlled to allow for future cable installation and to stay within the manufacturer's maximum allowable cable pulling tension. Conduit fill ratios shall not exceed the current requirements of the NEC.
- N. The maximum run length of each horizontal cable shall not exceed the 90m (~295ft) limit specified by ANSI/TIA 568.1-E. Notify the Owner's Representative immediately if, due to on-site conditions or other factors, a horizontal cable run length exceeds this distance.
- O. Provide Velcro hook and loop ties to secure cabling running in the Telecom Closets. Provide straps at 3' intervals. On completion of installation, neatly run and re-tie all cable bundles in the Closet.
- P. All cable bundles exiting floor or wall penetrations and running into furniture or casework shall be wrapped in spiral wrap or split-loom tubing to protect the cabling and provide a neat installation.
- Q. All Wireless Access Points should be ceiling-mounted no less than 4ft from any wall. Do not mount any Wireless Access Point within 4ft of any projector. WAPs need to be mounted with best-practices in mind and provide the greatest and most efficient coverage.
- R. WAP Cat 6A patch panel(s) shall be mounted at the top of the rack, directly below the Fiber Optic patch panels.
- S. Labelling Scheme:
 - 1. Interior data drops – The standard is IDF, Rack, Patch Panel, Cable Number (e.g. 1A-1A01)
 - 2. Exterior data drops at the patch panel shall also be labelled with a 3-letter abbreviation describing intended use in addition to the interior drop labeling. (I.E. 2A-1A01-CAM / 2A-1A01-SPK / 2A-1A01/WAP), where CAM = camera, SPK = speaker, CBP = Code Blue Phone, and WAP = Wireless Access Point. Coordinate with MCC representative for other devices not mentioned here.

3.5 COMMUNICATION UTILITY VAULTS AND PULL BOXES

- A. General
 - 1. The Contractor shall obtain all required permits and notifications before commencing any work operations.



2. All state and local ordinances shall be complied with at all times.
 3. All federal, state, and local safety rules, including OSHA, will be enforced at all times during the duration of the project. It is the responsibility of the Contractor to inspect the job site to ensure compliance.
- B. Final location of all communications utility vaults and pull boxes shall be determined by the Contractor and Engineer of Record. All manholes to have a minimum cover of 2 ft. measured from final grade to top of manhole.
 - C. All conduits entering a utility vault or pull box shall be installed at right angles to the short walls and shall be sealed to prevent seepage unless otherwise specified on the construction documents.
 - D. Excavation dimensions shall be verified with the utility vault supplier in advance so as to prevent delays in setting schedule.
 - E. Shoring shall be in accordance to prevailing underground construction codes, i.e., OSHA, G. O. 128, NESC, and all applicable local, state, and federal statutes.
 - F. All utility vaults shall be equipped with pulling irons.
 - G. Finish grade shall be established prior to placing structures.
 - H. The Contractor and the Inspector of Record shall inspect all utility vaults prior to backfilling.
 - I. Backfill materials shall have been sifted to provide a sand equivalent of not less than 20, and a sieve size of No.4 Backfill material shall be mechanically compacted to a minimum relative compaction of 90 percent to a level six (6) inches above final grade. The excess material shall be excavated to the final grade upon acceptance of compaction.
 - J. Existing and/or new communications utility vaults/pull boxes may be installed near the existing power and signal vault system. The Contractor shall either install new or enlarge existing utility vaults/pull boxes and conduits in such a manner as to not disturb existing utilities while maintaining specified clearances from all obstructions. This may require clearing much of the area around the vaults by hand. The final Installment and depth shall be determined by the Contractor and Engineer/Inspector of Record.
 - K. The Contractor shall locate all existing utilities within 20 feet of the new and/or enlarged utility vault/pull box system. The Contractor and Engineer/Inspector of Record shall review and approve any revised coordination schematics. Caution shall be used when working in this area.
 - L. The Contractor shall excavate around existing vaults using caution to identify and preserve all utilities in the area.

3.6 3.6 DUCT BANKS AND CONDUITS

- A. All communications conduit ducts shall be encased in 2-sack concrete mix slurry with at least 3 inches of concrete at the top and bottom and 3 inches on each side. A horizontal and vertical
- B. separation of 2 inches between the ducts shall be maintained by installing high impact spacers with horizontal and vertical locking intervals of ten feet. The top surface of the concrete encasement shall include an orange color dye for future identification.
- C. All communications conduits shall be installed in a uniform manner between vaults. Conduit in position #1 at one utility vault shall maintain its position within the duct run and terminate in the #1 position at the next utility vault. The position of all conduits between utility vaults shall be maintained.
- D. Long radius bends (over 30 feet) shall be used whenever possible to make changes in direction. If it is found to be necessary to install a 90-degree bend in the conduit run, a factory-made sweep of no less than 12 feet 6 inches radius shall be used. No conduit run shall exceed a total of 180 degrees of bend between any two points (such as utility vaults or buildings) considering both vertical and horizontal sweeps. Cold-formed trench bends shall have a radius of not less than 40 feet and shall pass mandrel integrity. Bend radius criteria are 2" or less 6 times the diameter of the conduit and, for any conduit larger than 2", 10 times the diameter of the conduit.

- E. The length and destination of all conduits shall be identified in each utility vault, pull box, and building. Embossed metal or heavy plastic tags strapped to each conduit shall be used.
- F. After installation of communications conduit and after the concrete encasement has cured, the Contractor shall prove all conduits by pulling a mandrel with a diameter $\frac{1}{4}$ inch smaller than the conduit and 12 inches long through each conduit end-to-end. The Inspector of Record shall be notified 24 hours before this procedure. Each conduit shall be cleaned with a bristle brush to remove any debris.
- G. All utility vault and pull box entrances shall be shear-blocked with standard concrete extending no less than 15 inches from the entry wall. All entering ducts shall be completely encased.
- H. Utility marking tape shall be buried 12 inches below the surface directly above the conduit.
- I. All conduit structures shall be built with the telecommunications conduits installed above the power conduits with a minimum of 12 inches of separation unless otherwise called out on the construction drawings. If this type of construction is required, it shall receive prior approval of the Engineer of Record.
- J. All entrance conduits shall be securely fastened to the building. The end of the conduit located inside the building shall be sealed to prevent rodents, water, or gases from entering the building.

3.7 ENTRANCE CONDUIT

- A. Install entrance conduits of Rigid Steel 4" conduits from within 24" of new building foundation and all the way to the telecom room (BDF) of the new building.
- B. Underground detectable warning tape shall be installed in all trenches at one foot below the final grade after the conduit and encasement is complete. The tape shall indicate the type of cable that will utilize the substructure system, e.g., fiber optic or copper cables. The detectable warning tape shall be installed according to manufacturer's specifications to ensure access to the tape for locating purposes.

3.8 MULE TAPE

- A. Mule tape shall be new material that is free of knots, kinks, and abrasions.
- B. Mule tape shall be installed as a single continuous length in every new conduit, no splicing will be allowed.
- C. Mule tape shall be installed in all conduits to include an additional 10-feet of slack remaining on each end secured to loop-eye end of expanding rubber type duct plug.

3.9 BONDING/GROUNDING

- A. Bonding conductors shall be routed with a minimum number of bends. The bends placed in the conductor should be sweeping.
- B. All bonding connections shall utilize listed bolts, crimp pressure connectors, clamps, or lugs. Exothermic welding may be used.

3.10 UNUSED COMPONENTS

- A. Any components purchased in accordance with these specifications and unused shall be documented and passed to the owner on completion of the project.

3.11 TESTING

- A. General Instructions.
 - 1. The testing is to show beyond reasonable doubt that there are no errors, damaged or incorrectly installed components, that the installation is correctly labeled and that all the installed components meet or exceed the criteria detailed in these specifications. Any test that does not show that a component is satisfactorily installed, as per these specifications, shall be repeated. If a test procedure needs to be modified to satisfactorily test some components, the modification shall be submitted for approval of the Owner's Representative, prior to the tests being conducted.
 - 2. Following optical fiber and data cable installation, including labeling and termination at both ends, undertake and record tests to ensure that the cabling system will perform satisfactorily in service. In addition to the tests detailed in this specification, the Installer shall carry out any additional tests

- that the Installer deems necessary to ensure the satisfactory operation of the telephone and data systems. The costs of these additional tests shall be borne by the Installer.
3. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to testing. Any testing performed on incomplete systems shall be redone on completion of the work.
 4. Provide the Owners' Representative with the opportunity to witness all testing. On reasonable request, the installer shall demonstrate that the test procedure competently identifies the fault conditions being tested for.
 5. Complete all the tests identified in these specifications.
 6. Notify the Owners' Representative ten working days before the date of commencement of the cable tests. Provide details in writing, on that advance date, of proposed tests, the test schedule, equipment to be used, its certification and calibration and the names and qualifications of test personnel.
 7. The Owner and Owners Representative shall be invited to the first instance of each type of test conducted. In the event of any number of tests being conducted by the Installer prior to this first inspection, the Owner's Representative reserves the right to reject these tests as non-compliant and require them to be repeated at the Installer's cost.
 8. The owner will reserve the right to request the use of the specific tester used by the contractor to conduct a random test of approximately 5% of the installed cables. If the measurement results differ appreciably (+/- 20%) from those of the contractor provided report, then the sample will be expanded to 20% and be re-tested by the contractor under the observation of the customer. If the variances continue then the customer reserves the right to request a 100% re-test of the installation by a mutually agreeable third party, at the expense of the contractor.
 9. Include the cost of obtaining, calibrating, and maintaining test equipment and the cost of carrying out and recording the tests detailed in this specification, including labor costs, in the bid sum. No extra costs will be entertained.
 10. Ensure that all test equipment is in calibration before delivery to site and throughout the testing period. The Installer shall be responsible for ensuring that any necessary tests and rework to maintain the equipment's calibration status is carried out. Any tests performed on uncalibrated test equipment shall be repeated at the Installer's cost.
 11. The test documentation shall be available for inspection by the Owners' Representative during the installation period and copies shall be passed to the Owners' Representative within five working days of completion of tests on cables in each area. The Installer shall retain a copy to aid preparation of as-built information.
 12. Failures detected during the testing shall be noted on the test results schedule, rectified and re-tested. Once the fault is rectified, this shall also be noted. These notes shall not be deleted or obliterated.
 13. Rectification of all damaged cables shall include replacing damaged cables with new cables in complete runs, replacing damaged connectors or remaking poor terminations. In-line cable joints, splices or distribution points will not be acceptable except where specified in this document. All damaged cables shall be removed from the site.
 14. If on submittal of the As-Built documentation there are any missing test results or incorrectly named files, the test shall be repeated at the Installer's expense.
- B. Category 6/6A Cabling
1. Test each Category 6/6A Cable and its associated connectors. Carry out the following tests on every pair of every Category 6/6A cable:
 - a. Wire Map
 - b. Length
 - c. Insertion Loss
 - d. NEXT Loss
 - e. FEXT Loss
 - f. ELFEXT



- g. Propagation Delay and Delay Skew
 - h. Return Loss
 - i. Power Sum Near-End Crosstalk (PSNEXT) Loss
 - j. Power Sum Equal Level Far-End Crosstalk (PSELFEXT)
- C. Work Area Faceplates and Blanking Plates
1. Carry out a visual inspection of the faceplates and blanking plates. Replace all damaged components.
 2. Ensure that all faceplate labels are installed correctly.
- D. Optical Fiber Cabling
1. Test each Optical Fiber Cable and its associated connectors. Carry out the following tests on every element of every optical fiber cable:
 - a. Length
 - b. End-to-End Attenuation
 - c. Connector Loss
 - d. Splice Loss
 - e. Power Loss
 2. The tester shall have the following parameters:
 - a. Optical Time Domain Reflectometer (OTDR) shall be used to test every optical fiber cabling.
 - b. OTDR shall be used to test optical in both directions and take the average. Provide a launch lead and far end drop off lead.
 - c. Singlemode optical fibers shall be tested at 1310nm and 1550nm.
 3. Test each optical fiber cable element and its associated connectors. Carry out the following test on every element of every optical fiber cable:
 - a. Visually check optical connectors using microscope (minimal magnification x200) to ensure that no physical damage has occurred during the installation process. There are to be no scratches on the core of the fiber or pits on the core or cladding. If any defect cannot be rectified with polishing, the connector is to be replaced.
 - b. Carry out OTDR tests on all elements at 1300nm wavelength for multimode cable runs and at 1310 nm for singlemode. These tests shall be carried out from both ends using a near end launch lead and a far end drop lead.
 - c. The number of samples (averages) for each OTDR test shall be such that the noise amplitude is significantly less than the smallest loss of any component under test. This may vary for different cable runs, for shorter runs and fusion splices etc.; it may be necessary to run many samples.
 - d. Record the length and loss of each mated connector pair on the test results schedule for all elements.
 - e. Verify the labeling of the cable and connectors is correct.
 - f. If an element has an excessive attenuation coefficient, a sudden step in attenuation coefficient (greater than 0.2 dB) or back scatter, losses due to micro bending or macro bending or has any other fault then the fault on that element shall be rectified.
 - g. The following table lists the pass/fail criteria for all connectors and fusion splices under test. Any component that does not pass these figures shall be re-worked or replaced.

Element Type	Maximum attenuation across mated connector pair (dB) – outward test	Maximum attenuation across mated connector pair (dB) – return test	Maximum Attenuation across fusion splice – averaged over both directions(dB)	Minimum Return Loss (dB) – outward test	Minimum Return Loss (dB) – return test
SM	0.5	0.5	0.1	36dB	36dB



- h. The attenuation of each singlemode connector shall be measured in both directions.
- i. Each fusion splice shall be tested in both directions for both multimode and singlemode elements. The measurements for each direction shall be averaged for the final attenuation figure for each fusion splice.
- j. The return loss must be measured in both directions for singlemode connectors. The return loss shall be greater or equal to the value shown in the table above.
- k. Any failures shall be recorded (including value of excessively lossy terminations) and the results obtained after rectification of the fault shall be recorded.
- l. Refer to section 1.10.H.4 of this document for requirements pertaining to test result submittals.

Confidentiality: Drawings and specifications involving the communications cabling system represent a vulnerability to the security of the facility and are to be considered confidential information.

END OF SECTION 27 10 00



SECTION 27 41 16
AUDIOVISUAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following equipment, furnished and installed by the Audiovisual (AV) Contractor:
 - 1. Bill of Materials as required by Project.

1.2 QUALITY ASSURANCE AND GENERAL CONDITIONS

- A. Work and materials shall comply with the rules and recommendations of:
 - 1. Prevailing national, state and local building codes.
 - 2. UL, ETL, cUL, CSA and CE Labels – where materials and equipment are available under the continuing inspection and labeling service of applicable independent product testing and certification services, provide such labels, materials, and equipment.
 - 3. ANSI/PLASA Remote Device Management (ANSI/PLASA E1.20 RDM) and Architecture for Control Networks (ANSI E1.17-2006 ACN & E1.31 Streaming ACN) standards.
 - 4. Institute of Electrical and Electronics Engineers, Inc. (IEEE) 802.3 and 802.11n.
- B. The Invitation for Bids, Instruction to Bidders, and General Conditions of the Contract including any Supplementary Conditions apply to all Work under this section.
- C. The Contractor acknowledges and warrants that he has closely examined all the Contract Documents, that they are suitable and sufficient to enable the Contractor to complete the Work in the time allotted for the Contract Sum as accepted by the CM and Consultant, and that they include all Work, whether or not shown or described, which reasonably may be inferred to be required or useful for the completion of the Work in full compliance with all applicable codes, laws, ordinances, rules, and regulations.
- D. Execution of the Contract by the Contractor is a representation and warranty that the Contractor has carefully examined the Contract Documents, and represents and warrants that the Contractor is thoroughly familiar with the nature and location of the Work, the Site, the specific conditions under which the Work is to be performed, and all matters which may in any way affect the Work or its performance. The Contractor further represents that as a result of such examinations and investigations, the Contractor has thoroughly reviewed and understands the Contract Documents and their intent and purpose, and is familiar with all applicable codes, ordinances, laws, regulations and rules as they apply to the Work, and that the Contractor will abide by same.

1.3 INSTRUCTIONS TO BIDDERS

- A. Definitions
 - 1. Bidding Documents include the proposed Contract Documents, which consist of the project Specifications herein and the associated AV category drawings.
 - 2. A Bid is a complete and properly signed proposal to do the Work as described in the Contract Documents, for the sums stipulated therein, submitted in accordance with the Bidding Documents.
 - 3. The Work includes all tasks necessary to complete the Contract as described in the Contract Documents.
 - 4. A Bidder is a person or entity that submits a Bid for coordinating and/or performing all the Work as described in the Contract Documents.
 - 5. A Sub-Bidder is a person or entity who submits a bid to a Bidder for materials, equipment, and/or labor for a portion of the Work.
 - 6. The Owner shall be the MiraCosta Community College District, also referred to as District herein.
- B. Bidding Documents
 - 1. Copies



- a. The Construction Manager will issue bidding documents directly to the bidders.
 - b. Bidders shall be responsible for providing copies of the Bidding Documents to Sub-bidders to solicit services to be Sub-Contracted.
 - c. In making copies of the Bidding Documents available on the above terms, the District does so only for the purpose of obtaining Bids on the Work and do not confer a license or grant permission for any other use of the Bidding Documents.
2. Interpretation or Correction of Bidding Documents
 - a. Bidders and Sub-Bidders shall carefully study and compare the Bidding Documents with each other to the extent that it relates to the Work for which the Bid is submitted, and shall promptly notify the District of any ambiguity, inconsistency, or error which they may discover.
 - b. Bidders and Sub-Bidders requiring clarification or interpretation of the Bidding Documents shall make a request to the District through the general contractor at least five (5) working days prior to the date of receipt of Bids. Requests for Information (RFI) shall be written and emailed to the General Contractor. No questions will be answered by telephone.
 - c. The District will make clarifications by Addendum and/or by written response if deemed necessary.
 3. Addenda
 - a. Each Bidder shall ascertain, prior to submitting a Bid that the Bidder has received all Addenda issued, and the Bidder shall acknowledge their receipt in the Bid.
 - b. Consideration of Bids
 4. Rejection of Bids
 - a. The District shall have the right to reject any or all Bids and to reject a Bid not in compliance with bidding procedures and requirements, no accompanied by data required by the Bidding Documents, or in any way incomplete or irregular.
 - b. The District shall also have the right to reject any or all Bids when, in their judgment, it is in their best interest to do so.
 5. Acceptance of Bids
 - a. The District shall be the final judge of which Bid is accepted.
 - b. The District shall have the right to waive informalities or irregularities in a Bid received and to accept a Bid which, in their judgment, is in their best interest.
- C. Bidder Requirements
- a. **EXPERIENCE:** Bidder shall have a minimum of ten (10) years' experience with the design, engineering, assembly, installation and support of audiovisual systems of similar or greater complexity to those identified in the accompanying specifications.
 - b. **TURN-KEY PROJECT: THIS WILL BE A TURNKEY PROJECT. ANY ITEM OF EQUIPMENT OR MATERIAL NOT SPECIFICALLY ADDRESSED ON THE DRAWINGS, SPECIFICATIONS OR ELSEWHERE IN THIS DOCUMENT, BUT REQUIRED TO PROVIDE COMPLETE AND FUNCTIONAL SYSTEMS AS CONTEMPLATED AND/OR SPECIFIED HEREIN, SHALL BE PROVIDED AT NO ADDITIONAL CHARGE TO OWNER IN A QUANTITY AND QUALITY CONSISTENT WITH OTHER SPECIFIED ITEMS.**
 - c. **PRICING ALL-INCLUSIVE:** Bid pricing shall be all-inclusive and represent a complete fully engineered turn-key system installation at the Project site as contemplated by the accompanying specifications. It is the responsibility of the Contractor awarded this project to ensure that all quantities, materials, labor, licenses, permits, sales taxes and any and all other costs to provide a turnkey project are included in their bid price.
 - d. **OMISSIONS:** Bid omissions of any provision herein described shall not be construed as to relieve the Contractor of any responsibility or obligation requisite to the complete and satisfactory design, engineering, purchase, delivery, installation, operation and/or support of any and all systems, equipment or services. Correction of any omission on the part of the Contractor, either due to misinterpretation of the specifications or any



- other conditions of the project, shall be the responsibility of the Contractor and shall not result in any contract modification or additional costs to District.
- e. **MANUFACTURER AUTHORIZED AND CERTIFIED:** Bidder shall certify that is has been a Manufacturer-Authorized Channel Partner for all specified systems/equipment for at least twelve (12) consecutive months prior to the specifications Release Date, and that it has the certification/specialization level required by bid Manufacturer(s) to design, engineer, configure, sell, install, commission and provide Warranty support in the Los Angeles / Orange County California geographic area for all bid systems and components in accordance with the applicable Manufacturer certification/specialization requirements. The contractor selected for this project must adhere to manufacturer specified design, engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this project. Current valid certifications for all specified equipment **MUST** be provided with your bid. Absence of providing such certifications may be cause for Bid disqualification.
 - f. **NEW EQUIPMENT ONLY:** Unless otherwise specified, Bidder shall warrant that all bid products and materials are new, of the latest design and engineering level, are free of operational or cosmetic defects, and are delivered in their original packaging. By submitting a bid, Bidder confirms that they have sourced all products bid from Manufacturer or through Manufacturer-Authorized Channels only, in accordance with all applicable laws and policies at the time of purchase.
 - g. **DOCUMENT CONFLICTS:** All specifications must be adhered to. Where conflicts and/or irregularities occur between specification sections or documents, drawings, and/or applicable codes, rules, regulations, ordinances, standards, guidelines and practices, the more stringent requirement shall apply as reasonably determined by Owner or government agency inspector.
 - h. **FULLY ENGINEERED SOLUTIONS:** The designs in the accompanying specifications do not represent fully engineered technical solutions. Bidders are required to review the designs presented closely, submit any questions and clarifications regarding the design intent through the RFI process, and develop their own engineered solutions representing a fully functional turn-key solution in their bid responses.
 - i. **COMPLETE SYSTEM:** The scope of this project includes the complete system engineering, procurement of ancillary equipment as may be required, fabrication, installation, programming, testing, training and warranty of an Audiovisual (AV) system as described in the accompanying specifications. Bid solutions shall be based on the designs communicated in the accompanying specifications, but shall include any additional equipment, materials and/or labor required for the Bidder to deliver a fully functional turn-key system solution that meets intended operational performance requirements.
 - j. **SUBCONTRACTING:** The following information must be provided with your Bid in order to be considered for award:
 - a) Name and address of ALL subcontractors that will be involved in this Project as Bid
 - b) Description and percentage of work to be performed by each subcontractor
 - c) Cost associated with each subcontractor's work
2. **LOCAL FABRICATION FACILITY:** Bidder shall maintain permanent fabrication, service and support facilities within (100) miles of the Project site.
 3. **REFERENCES:** Bidder must provide a minimum of three (3) references in the greater Los Angeles / Orange County CA area that Owner may contact for whom you have provided AV system installations of similar size and scope to those requested in these specifications in the past two (2) years. Bidder must indicate:
 - a. Project name and location
 - b. Client/Owner reference, including contact name and telephone number
 - c. Project Architect, including contact name and telephone number



- d. Total project contract value and duration
- e. Description of the project and summary of the AV system scope
- f. Name of your Project Manager responsible for the project

1.4 SUMMARY OF WORK

- 1. Summary of Work as required by Project.

1.5 SCOPE

- A. Supply and install sound and video systems including all apparatus and equipment, wiring, termination, labor, and services required to provide systems as specified and shown on drawings.
- B. Supply and install any incidental equipment needed in order to meet the functional requirements stated herein and on drawings. This shall include all support and restraint for the fixed loudspeakers and projection equipment.
- C. Set up and adjustment of specified hardware and software.
- D. Furnish all test equipment and the services of the project engineer and the project manager to assist the District in the acceptance testing.
- E. Make any adjustments to any part of the system which may be found necessary during the acceptance testing.
- F. Provide training in the operation of the systems to the person or persons selected by the District.

1.6 COORDINATION

- A. Schedule installation operations in sequence required in order to obtain best completion results. Installation shall not be scheduled for a date prior to the environment being dust-free and climate-controlled.
- B. Coordinate the procurement and installation of the flat panel displays, media input panels and all speakers with the District.
- C. Coordinate installation of different components to assure maximum accessibility for required maintenance, service, and repair.
- D. All specialty sub-Contracting including coordination of all telecommunications lines with other subcontractors and equipment as shown on the Contract Documents to be coordinated by the Contractor.
- E. Coordinate the configuration of IP-based devices that are to be connected to the District's network. Contractor shall coordinate with the District.

1.7 EQUIPMENT AND MATERIALS

- A. The AV Contractor shall verify characteristics of elements of interrelated equipment specified under this section are compatible; coordinate work having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- B. By making requests for substitutions, the Contractor:
 - 1. Represents that he has personally investigated the proposed substitute product and determined that it is equal to or superior in all respects to that specified.
 - 2. Represents that the proposed substitute product shall be fully compatible with all other equipment specified within the project or referenced in the District's AV Equipment Standard.
 - 3. Represents that he will provide the same warranty for the substitution that the Contractor would for that specified.
 - 4. Certifies that the cost data presented is complete and includes all related costs under this Contract, and waives all claims for additional costs related to the substitution which may later become apparent.



5. Will coordinate the installation of the accepted substitute, making such changes as may be required for the Work to be complete in all respects, including, but not limited to, in full compliance with all applicable codes, laws, ordinances, rules, and regulations and completion in the time allotted for the Contract Sum as accepted by the District.

1.8 SCHEDULE

- A. Within ten (10) calendar days of the receipt of the notice to proceed the AV contractor shall prepare and submit for approval, in accordance with the General Conditions, a schedule which shall include, but is not limited to, the following:
 1. Submission of shop drawings, samples and layouts for all items described herein.
 2. Start and Completion date(s) for field installation work.
 - a. Installation date(s) of all wires and cables in conduits and required cable trays.
 - b. Date when fully-operational equipment racks will be fully tested and ready for District's observation.
 - c. Delivery date(s) of all systems and subsystems to the project site.
 3. Start and Completion date(s) for shop fabrication work.
 4. Date of submission of samples for approval by the Architect of all finishes/materials which will be visible to the public. Refer to Part 1 paragraph 1.8 entitled "Submittals" for additional information.
 5. Programming of all remote control and Digital Signal Processing driven devices.
 6. Completion dates(s) for the following tests:
 - a. Performance tests on all individual AV components as they are received from the manufacturer in the AV contractor's shop.
 - b. Performance tests on completed assemblies and subassemblies assemblies, including all racks in the AV contractor's shop.
 - c. Performance tests on the completed systems as a whole prior to shipment to the project site.
 - d. General performance testing of systems at the project site.
 7. Completion dates for the following Shop and Field Observations.
 - a. Shop fabricated assembly and subassembly observation.
 - b. Substantial Completion Observation at the project site.
 - c. Final acceptance observation at the project site.
 - d. Submission date for operating, maintenance manuals, as-built drawings, documentation, and closeout materials.
 8. In the event the AV contractor wishes to deviate from the schedule once it is established and approved, he may do so only after receiving written approval from the District.

1.9 SUBMITTALS

- A. All submittals shall be in accordance with the general provisions of the Contract, including General and Supplementary conditions and other Division 1 Specification Sections.
 1. District will not review partial submittals.
 2. District will review up to two (2) submittals of any one submittal topic.
- B. Substitutions of equal equipment beyond the alternatives listed will be permitted only in accordance with Division 1. If a requested substitution requires a change in any of the contract drawings, a revised drawing must be submitted as part of the substitution request. If an alternative listed is discontinued prior to installation, the Contractor shall submit a substitution request to provide the manufacturer's replacement model. The District shall be the final judge of the acceptability of substitutions.
- C. All drawings shall be clear and legible. The minimum text size for all drawings shall be 1/8" high.
- D. **Post Award Submittals: submit within 60 days of award.**
 1. Submit electronic reproducible drawings (as .dwg AND .pdf), documents (as .pdf) and software as per manufacturer's directions of the following:



- a. A statement of subcontractors, franchises, distributorship, dealerships, arrangements and agreements with manufacturers of equipment to be used for this work.
 - b. Complete bill of quantities, including all material, components, devices and equipment required for this work. The bill of quantities shall be tabulated respective of each and every system as specified, in the order of the specification section 2 below, and shall contain the following information for each item listed:
 - a) Quantity
 - b) Description
 - c) Manufacturer's name and model number
 - d) Manufacturer's specification sheet
 2. Samples of approval by the Architect of all finishes/materials which will be visible to the public. Including at least receptacles and controls with associated trim plate and each type of loudspeaker baffle and/or grille.
 3. Schedule for work as described herein showing all major milestones.
 - a. Receptacle Location Plan: a plan of the relevant parts of the building showing locations and designations of all receptacles.
 4. Floor plans, at scale of Contract Documents, showing the locations throughout the project of all receptacles, conduits, wireways, trays, pull boxes, junction boxes, equipment racks equipment and other devices with appropriate designations and fill.
 5. Functional Diagrams: single-line block diagram showing interconnection of all components, receptacles, terminal blocks, controls, transformers, and loudspeakers in addition to the active elements. Include terminal and cable numbers, all system and component labels. Show detailed system component information including but not limited to manufacturer's name, model number, any specialized part number option and all input and output connection information, for each piece of equipment. No drawing codes shall be permitted.
 6. Equipment rack elevation drawings scaled (1-1/2" = 1'-0" or larger):
 7. Front Elevations: include equipment designation, manufacturer's name, model number, rack location and rack designation.
 8. Samples for approval by the Architect of all finishes/materials that will be visible to the public including at least receptacles and controls with associated trim plate and each type of loudspeaker baffle and/or grille.
 9. Cable schedules and run sheets, associates with each equipment rack and/or any isolated piece of equipment or device, including cable designation, type, manufacturer and manufacturer's type number, wire color, device and terminal designation and device location, keyed to both the system block diagram and equipment rack elevation drawings.
 10. AV contractor fabricated items, detailed drawings showing all components, devices and equipment, including dimensions, component values, terminal designations, types, locations, manufacturer's name and model number.
 11. A bound volume or volumes of comprehensive specifications for all material, devices, components and equipment selected for use in this section, whether modified or not, provided as required under "Post Award Submittals" above.
 12. Control panel Layouts: Developed drawings of all control system panel layouts.
- E. Digital Signal Processor (DSP) System Submittal for Owner Review
1. Prior to programming the Digital Signal Processing (DSP) system, the AV contractor shall submit shop drawings per the project standards showing all screen layouts and control descriptions of all system functions to the District for review and comment prior to actual programming of the system. Shop drawings shall include screen layouts of the DSP software "Control pages" for all "configuration-presets" and "parameter-presets". Submit electronic versions of the DSP software to the District for review and approval. The AV contractor shall incorporate all District comments into the programming of the systems.
 2. Prior to delivery of the systems to the job site, the AV contractor shall demonstrate fully functioning systems in the Contractor's facilities that include the DSP system programming. This demonstration shall coincide with the District's observation of Completed Sub-Assemblies (Refer to Part 3 paragraph 3.2 entitled "System Performance Tests"). The



District will review and comment upon the DSP programming, and the AV contractor shall incorporate all District comments into the programming of the systems.

3. After the installation of the AV systems and construction is fully completed, but prior to final acceptance of the system, the District shall have a review period of thirty (30) days to observe the operation of the DSP system. At the end of this review period, the District may request programming changes relating to the look and feel of the operation pages or the functionality of commands. The AV contractor shall make these changes prior to acceptance of the systems.
- F. Control System Submittal for Review
1. Prior to programming the remote control system, the AV contractor shall submit shop drawings per the project standards showing all control screen layouts, graphical user interfaces (GUI) and control descriptions of all remote control system functions to the District for review and comment prior to actual programming of the system. Submit in native file format and hard copy form. Shop drawings shall include control screen layouts of the touch panel pages for each venue, web page layouts (as required in Part 2 below). Submit electronic versions for District review. The AV contractor shall incorporate all District comments into the programming of the systems.
 2. Prior to delivery of the systems to the job site, the AV contractor shall demonstrate fully functioning systems in the AV contractor's facilities that include the control system programming. This demonstration shall coincide with the District's observation of Completed Sub-Assemblies (Refer to Part 3 paragraph 3.2 entitled "System Performance Tests"). The District will review and comment on the control system programming submittal, and the AV contractor shall incorporate all District comments into the programming of the systems.
 3. After the installation of the AV systems and construction is fully completed, but prior to final acceptance of the system, the District shall have a review period of thirty days to observe the operation of the control system. At the end of this review period, the District may request programming changes relating to the look and feel of the control panels or the functionality of commands. The AV contractor shall make these changes prior to acceptance of the systems.
 4. Digital Signal Processing and control system programming files, touch panel, & other control page & Graphical User Interface layouts in native file format and hard copy form.
- G. Shop Test Statement Submittals
1. Submit electronically - photographs and state of the following prior to shipping fabricated equipment racks to Project site:
 - a. A bound volume, or volumes, of results of performance tests and adjustment data, including all test procedures specified in Part 3 paragraph 3.2 entitled "System Performance Tests".
 - b. Submit a written request for equipment rack observation certifying that equipment racks are completely assembled, tested and ready for inspection.
 - c. Detailed interior and exterior photos of assembly supporting claim for readiness for inspection.
- H. Final Submittals: Submit the following Record Drawings developed from the final "as built" systems.
1. Two (2) copies and one (1) reproducible of each of the block diagrams, plans, risers, patch bay drawings, rack elevations, cable schedules and detail drawings. All reproducible drawings shall be submitted electronically via a secure file-sharing URL.
 2. No more than thirty (30) days after Acceptance Testing, submit two (2) physical copies of each of the following manuals prior to, and as a requirement of, Owner and Consultant Acceptance of the work of this section:
 - a. Equipment operating instructions: complete, comprehensive instructions for the operations of all contractor-fabricated devices and equipment items provided as part of the work of this section.



- b. Manufacturer's installation, operating and service information including schematic diagrams for each item of equipment furnished. Order the equipment manuals in the order of the specifications. Provide tabs between each equipment manual. Provide a detailed index at the front of each manual indicating specification reference number, manufacturer's trade name, model number and part description. Provide two (2) copies to the District.
 - c. Printed material within contractor-fabricated equipment and systems operating manuals shall be bond paper copies, offset or letterpress printed. Drawings, charts and graphs shall be bond paper offset printed. The systems contractor-fabricated equipment instruction manuals shall be composed using a single, consistent visual format and writing style; text shall be derived from component equipment manufacturer's instruction manuals and may include reproductions of artwork and other materials.
3. Submit two (2) copies of each of the following schedules, lists, and data prior to, and as a requirement of, Owner Acceptance of the work of this section:
- a. All source code for any contractor provided or programmed equipment shall be submitted electronically via a secure file-sharing URL.
 - b. Final bill of quantities; complete bill of quantities all material as delivered, including a separate schedule of portable equipment.
 - c. Equipment schedule: complete, final schedules of equipment and devices provided in each room, by room number and name.
 - d. Maintenance and spare parts schedules; a comprehensive tabulation of equipment, devices, miscellaneous parts and maintenance items, including manufacturer's name, address, model number, systems use and miscellaneous information.
4. No more than thirty (30) days after Acceptance Testing, provide one (1) copy of the following:
- a. Certificates: any and all licenses, certificates of operation and/or compliance as required.
5. The system will not be accepted until these documents are reviewed and approved by the District.

1.10 QUALITY ASSURANCE

- A. Unless otherwise stated, all electrical, electronic and optical equipment shall be a product of firms regularly engaged in the manufacture of electrical, electronic or optical equipment. The equipment shall be the latest model or type offered which meets the applicable specifications at the time of the submittal. Discontinued items replaced by newer models or versions should be submitted for approval. It shall be the AV contractor's responsibility to provide the District with information regarding discontinued products listed as alternatives in the specification. If an alternative listed is discontinued prior to installation, the Contractor shall submit a substitution request to provide the manufacturer's replacement model.
- B. Quality of workmanship and fabrication of all equipment and components, which are custom fabricated shall be comparable to professional equipment produced by specialized manufacturers of the trade involved and shall be verified by observation. Only firms having 10 years' experience in all aspects of the fabrication and installation of similar systems shall be allowed to perform the work.
- C. All materials and products shall be new and of professional quality. Unless specifically stated in the drawings or specifications, no existing or pre-owned materials shall be installed.
- D. The work specified herein, and in each of the allied sections, shall be accomplished by a single AV contractor experienced in the design, fabrication, installation, checkout and warranty contract management of systems such as those described in each section. This AV contractor shall have complete responsibility for the systems described herein and shall be the single contract point for the Architect and the District with respect to all work specified herein.



1.11 WARRANTY AND SERVICE

- A. The AV contractor shall warrant the installation free of faulty workmanship.
- B. All components, including solid-state devices, warranted free of defects for a period of one (1) year from date of final acceptance. This minimum warranty provision shall not diminish the terms of individual equipment manufacturers' warranties.
- C. Paint and exterior finishes, fuses and lamps excluded from above warranties except when damage or failure results from defective materials or workmanship covered by warranty.
- D. Provide maintenance service for a period of one (1) year after acceptance of installation.
- E. Response: Provide telephone warranty service within four (4) hours, with 48-hour on-site technical response time. Provide a technician on call from 7 a.m. to 9 p.m. seven (7) days a week.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Appendix Division 27 - Refer to the Major Equipment and Approved Manufacturers List.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. The following installation requirements shall govern the design, fabrication and installation of the system(s) specified herein. In case of a discrepancy between these overall system standards and the individual equipment item specifications, the latter shall govern: The equipment specified shall be installed according to standards of good human engineering practice and the conditions specified herein.
 - 2. Workmanship on the installed systems shall be of professional quality, best commercial practice and accomplished by persons experienced in the techniques and standards of the particular industries involved.
 - 3. The specifications describe required performance. The specifications with the contract drawings indicate a general design; it is the intention of the specifications that the AV contractor will supply from his background of experience and knowledge the necessary supporting details; for example, the implementation of specific components into functioning sub-systems.
 - 4. In general, the drawings show dimensions, positions, and kind of construction. The specifications describe materials, qualities and methods. Any work called for on the drawings and not mentioned in the specifications, or vice versa, shall be performed as though fully set forth in both. In case of differences between the drawings and the specifications, the decision of the District shall govern. Work not particularly detailed, marked or specified, shall be construed to be the same as similar parts or areas that are detailed, marked, or specified.
 - 5. Equipment markings shall present only needed information and be readable from the operator's normal work position. These markings shall be designed to minimize ambiguous interpretation.
 - 6. Control panels shall be designed to reduce chances of human error and controls shall be natural and consonant with normal operator expectations.
 - 7. All control consoles and their panel mountings shall be provided with the necessary controls, indicators and switches, etc., as outlined in the pertinent sections of this specification. The grouping of these facilities shall be in accordance with the associated drawings and shall, in all cases, be arranged to present an orderly, functional appearance. The layout of controls shall be such that priority of accessibility shall be given to those facilities which frequently require attention.



8. The total design of the system shall simplify the operator's task and ensure maximum performance and reliability while minimizing possibilities for human error and providing a comfortable environment for the operator during operation.
 9. At the operational level (i.e., patch panels, AV equipment receptacle boxes, etc.) all receptacles shall be clearly marked by function and number. When there are multiples of the same function for example, a given microphone line may appear at several locations, the same label shall be shown at each location.
- B. The Conduit System
1. The Electrical Contractor is bound to provide the conduit system shown on the LV category drawings as part of the base building contract.
 - a. If any portion of the conduit installation is concurrent with the AV contract, the AV contractor shall inspect the work at appropriate times during construction and report any discrepancies to the Architect and Construction Manager in writing. The AV contractor shall coordinate the exact location of intermediate collector boxes behind the equipment rack with the electrical contractor.
 - b. The Electrical Contractor is bound to verify continuity of all conduits as described in the AV category drawings with a pull string.
 2. The AV contractor shall be responsible for supplying any additional conduit that may be required to complete the system installation in accordance with the drawings.
 3. It shall be the responsibility of the AV contractor to obtain the exact location of any pull boxes, "LBs" or other intermediate locations from the Electrical Contractor.
 4. The AV contractor shall also verify that conduits are adequate for the wiring and functions specified. If the AV contractor substitutes the specified wiring the AV contractor shall bear the sole responsibility for reengineering the conduit system.
 5. The AV contractor shall field-verify all back box installation conditions on site and shall size connection panels as described below. Notify the District of any discrepancies between AV drawings and installation conditions.
 - a. Surface Mounted Back Boxes: Connection panels shall be sized to match the outer edges of the installed back box and shall have smooth edges.
 - b. Recessed Mounted Back Boxes: Connection panels shall be sized to overlap the outer edges of the installed back box by 1" in both horizontal and vertical directions and shall be installed tightly against the wall surface finish.
 6. Each conduit shall contain wires or cable of the same signal level or the same type of circuitry only. Each separate service level designation shown on the AV conduit riser shall be run in their respective, separate conduits and all conduit landings in back boxes or equipment racks shall be grouped by service level.
 7. Ground power conduits to the power system ground. Do not connect power system conduits to the racks or to the audio system ground.
- C. Equipment Rack Assemblies
1. Equipment rack shall be completely assembled, tested and programmed in the AV contractor's shop if possible. No rack assembly shall be performed at the project site unless no other option is available. After the equipment rack is tested the AV Contractor shall notify the District in writing that the equipment rack assemblies are ready for observation and approval. Allow adequate time for any modifications necessary to satisfy the contract drawings and specifications.
 2. Use rear and mid rails for intermediate terminations. Maintain accessibility to the rear of the equipment.
 3. Mid rails must be used to support equipment weighing more than 50 pounds.
- D. Wiring Harness
1. Equipment rack wiring shall be "Harness" style. "Point to Point" rack wiring is not acceptable. The individual wiring harnesses shall be located at the rear of the equipment rack and individual pairs of cable shall be broken out to the pieces of equipment.



2. Electrical service levels shall not be mixed in an individual harness. It is the intent that there will be a separate harness for each electrical service level.
 3. Great care shall be exercised to keep low level signal harnesses separated from the AC power lines and high level signal harnesses.
- E. Equipment Labels
1. Rack-mounted equipment shall be labeled on front and back, as to function using engraved black/white laminated plastic blocks. For example: LEFT HI-FREQ AMPLIFIER or CENTER EQUALIZER. Provide label text to District for review and approval prior to ordering.
 2. Use permanent professional quality labels such as "Gravelply" or approved equal. Stick-on strip labels such as those from Dyno or Brother are not acceptable.
- F. Internal A/C Receptacles
- G. Maintain grounding as described in the herein.
1. Locate all internal AC receptacles on the left side of the rack and all harnesses on the right side of the rack. In the event that there are 2 equipment racks side by side locate the A/C receptacles in the middle of the equipment racks and the wiring harnesses to the outer sides.
- H. Installation
1. No equipment may be installed prior to the following:
 - a. The District has performed the AV Equipment Rack observation in the AV contractor's shop.
 - b. Any and all punch list items described as 'minimum to enable rack delivery to site' have been addressed, proof has been submitted to the District, and the District has approved rack delivery to site.
 - c. Notice has been filed with the District and the Architect, that a 'dust-free' environment has been achieved in the project in all areas where audiovisual system equipment is to be installed. Dust-free shall be defined as follows: all floor, wall, ceiling construction, millwork, finishes (including paint), carpet, hardware, electrical, and HVAC is absolutely complete (and tested and fully operational in the case of electrical and HVAC systems) before AV equipment racks may be delivered to the site.
 2. Where equipment rack(s) shall be installed in the MDF / TR room, the location is to be confirmed by the District.
 3. All stationary equipment rack(s) shall be secured to the building structure to meet seismic and code requirements.
 4. Great care shall be exercised to keep low level signal lines separated from the AC power lines and high-level signal lines.
 5. All connections of lines at terminal blocks, as well as at signal receptacles, shall be mechanically secured and then soldered. No unsoldered connections shall be permitted. Where lines approach the racks and terminal blocks they shall also be mechanically anchored at the rack, and provided with sufficient slack length to avoid strain, abrasion or wear.
- I. Wiring and Cabling
1. Extreme care must be taken to physically segregate and separate all high-level lines from lower-level lines.
 2. Control cables and power distribution wiring shall not be installed adjacent to signal cables. Power distribution cabling shall be on the opposite side from signal wiring in equipment enclosures and shall be uniformly located throughout an installation.
- J. Penetrations of Cabling in Construction
1. All cabling or system interconnection which passes through or into acoustically isolated areas, such as sound locks and studios, shall be suitably sealed after cable has been installed.

2. AV contractor shall provide all necessary fire stopping of openings through which cable is installed under this specification in accordance with NFPA 70 and all local codes. This includes installation in conduits, raceways, or bare penetrations in fire-rated barriers. All AV contractor installed "fire stop systems" must be UL approved including fire stop material (Fire Barrier Caulk), which must be UL 1479 approved.
- K. Wire Labels
1. During installation, both ends of all wires or cables shall be clearly labeled with approved wire labels.
 2. The wire labels shall be numbered consecutively with respect to the patch bay with a leading service level designation. If there are no patch bays utilized in the system, the wire labels shall be numbered consecutively with a leading service level designation.
 3. The wire labels shall not be more than 8 inches or less than 4 inches from the connector or termination at each end of the cable.
 4. Wire labels shall utilize plastic shrink-wrap, protecting the text and ensuring they remain affixed to the wiring. Approved: Thomas and Betts or approved equal, submit sample to the District for review.
- L. Documentation
1. Maintain a careful running log of route and terminations for each cable.
 2. A detailed wiring diagram shall be furnished with wire numbers shown as part of the as-built documentation.
- M. Cable Management
1. Cabling and wiring within the MDF / TR rooms, that is semi-permanent (i.e., those leading from rack to conduit terminus or rack to equipment locations) shall be carried not within conduit, but rather within ducts, troughs or cable trays mounted along walls or below the ceiling.
 2. Appropriate hooks along the wall or on the ceiling will aid in running occasional or frequently changed extension cables to use position.
 3. Cables shall be grouped and bundled by type and routed from source to termination in a uniform manner throughout all equipment housings. Care shall be taken not to break the insulation or deform the cable by harness supports. Cables shall not change relative position in a cable group throughout a cable route.
 4. Cable support bars shall be installed to support cables in areas of dense harness breakouts such as behind patch panels, distribution amplifiers and other multiple input/output devices.
 5. Edge protection material ("cat track") or grommets shall be installed on the edges of holes, lips of ducts or any other point where cables or harnesses cross metallic edges.
- N. Termination
1. The AV contractor shall employ the latest termination practices and materials.
 2. Signal and control cable ends shall be neatly formed, and shrinkable tubing shall be applied where necessary to secure the insulation against fraying or raveling.
 3. Field terminations shall be made with terminal blocks.
 4. Internal rack terminations and field terminations shall be made with terminal blocks.
 5. Punch block terminations are not acceptable and shall not be allowed.
 6. Coaxial connectors shall be crimp-on and then soldered. Audio and control wires shall be terminated with crimp-on lugs, and then soldered.
 7. Digital media cabling – submit proof of applicable cable termination training prior to installation and terminate per manufacturer's detailed instructions.
 8. All bare wire shall be tinned prior to termination unless the connector manufacturer recommends otherwise.
 9. Unused line level shields shall be individually insulated using shrinkable tubing and attached to the cable using an additional piece of shrinkable tubing.
- O. System Grounding
1. The "spider" concept is designed to avoid ground loops and inductive coupling.



2. The systems shall be hum free, stable and free of oscillation with the earth ground temporarily disconnected.
 3. The earth ground shall be made at only one point in the system as indicated and shall be in accordance with National Electric Code 2002 paragraphs 250.146(D), 406.2(D) and 408.20 Exception.
 4. The grounding method shall insure that the system is free of the following problems under any mode of operation:
 - a. RF oscillation, pickup and interference.
 - b. Distortion.
 - c. Crosstalk.
 - d. Signal Leakage.
 - e. Very high frequency feedback.
 - f. Audio Hum.
 5. Major wiring ducts or trays in the MDF / TR room shall be grounded to the conduit system.
 6. The equipment racks shall be isolated from, and not electrically bonded to, the building conduit system. This means that the conduit system shall not be electrically connected to the equipment racks and that the equipment racks shall be installed so that they are electrically isolated from the building structural steel. The racks shall be electrically bonded at only one point to the isolated grounding system as shown on the AV category drawings.
- P. Seismic Restraints
1. All hanging or free-standing equipment and cabinets furnished including but not limited to racks, loudspeakers, projection screens, and TV monitors shall be secured to substantial building structures. The equipment described shall resist seismic acceleration in any direction up to a limit of the greater of 1.0 G or the limit prescribed by the local governing codes.
 2. Maintain electrical isolation between the equipment racks and building steel.
 3. Loudspeaker hanging details, rack bracing, and other seismic restraints are not shown on the contract drawings; it shall be the AV contractor responsibility to develop these drawings.
 4. Submit loudspeaker mounting (rigging) drawings to the Architect for review after they have been stamped and signed by a licensed structural engineer engaged in regular practice in the Project's State.
- Q. Audio System Processing Adjustments
1. The AV contractor shall program the Digital Signal Processing system to include filters adjusted such that the loudspeaker zone(s) effected by same are measured to exhibit uniform (flat) frequency response (less than +/- 3 dB) at the listening location for the frequencies the transducer is designed/intended to address. Measurements utilized for determining filter adjustments shall be made on axis with respect to a single transducer (representative of the zone) in its intended field of coverage. Loudspeaker cross-over filters shall be provided first for all actively crossed transducers per loudspeaker manufacturer's instructions. Additional filters will still be required to achieve uniform frequency response measured at the various listening locations. For loudspeaker zones of small transducers, utilize high-pass filters first and foremost and then utilize parametric EQ filters to flatten the measured response. For loudspeaker zones of large transducers, where other transducers in the system will address higher frequencies, utilize low-pass filters first and foremost and then utilize parametric EQ filters to flatten the measured response.
 2. The AV contractor shall program the Digital Signal Processing system to include delay settings adjusted so that the direct sound from the main loudspeaker clusters and the delay zone transducers in question arrives simultaneously at the listening plane served by the delay zone transducers. The District may request additional delay to address 'imaging / Haas effect preferences' as appropriate.



3. The District may add additional filters and delay (as required) to address 'tuning preferences', but such 'tuning preferences' shall not be considered as part of the base line requirements for determining substantial completion of the audio system. Flat frequency response and time alignment of the direct sound from the loudspeakers will be considered a base line requirement for determining substantial completion of the audio system.
- R. Loudspeaker Installation
1. Verify all loudspeaker aiming and positioning with the District.
 2. Submit loudspeaker mounting (rigging) drawings to the Architect for review after they have been approved and signed by a certified structural engineer engaged in regular practice in the Project's State.

3.2 SYSTEM PERFORMANCE TESTS

- A. General
1. The AV contractor shall pre-assemble and test all systems and sub-systems in AV contractor's own facility before completed assemblies are delivered to the project site.
 2. Tests shall include but are not limited to those listed below in order to verify that the system meets all design requirements.
 3. The AV contractor shall perform the initial system testing and adjustment prior to scheduling the final system acceptance tests.
 4. All tests shall be fully documented, and a neat copy presented for review by the District and inclusion in the system manual.
- B. Performance Tests on Individual Components
1. Perform in AV contractor's facility.
 2. Verify that the manufacturer's specifications are met.
- C. Performance Tests on Completed Component Sub-assemblies
1. Perform in AV contractor's facility.
 2. Before delivery of the equipment to the project site, the specialty AV contractor shall demonstrate to the District at the AV contractor's facilities that all sub-assemblies are operating as specified.
 3. Verify the achievement of the specifications for each electronic component in situ, i.e., as assembled in its console, rack or other enclosure, powered by the system power supply and with all other components also activated, i.e., powered and interconnected. The magnitude and character of the threshold noise shall be observed for appearance of hum in excess of that present with individual activation, or the appearance of high frequency oscillation.
 4. Projection equipment shall be tested to verify that the manufacturer's specifications are met after it has been incorporated into a complete subassembly.
- D. Performance Tests on the Complete System
1. Verify that all wiring is correctly and completely installed. Verify that there are no short circuits between conductors within any cable, or from cable to cable. Verify the integrity of each conductor, i.e., that the conductor is not open circuited. In addition, the correct polarity of each connector, including those in patch panels, shall be verified and the color-coding scheme shall be recorded and included in the documentation provided to the District.
 2. Verify that the entire system performance is in accordance with the design requirements. Specific attention is directed to the following for each system:
 - a. Video Display image quality / viewability
 - b. Source Equipment Transports
 - c. Video Switchers
 - d. Control System Components
 - e. Audio Amplifiers
 3. The threshold noise output of the system, measured at the output of the power amplifier, must equal the input when its gain control is full on, and of the line or booster amplifier



input when all channel controls are off. No hum shall be audible in the system within the noise signal, or with the inputs terminated in microphone impedance and all controls full on. No high frequency oscillation shall be observed at the system output. No audible radio signal shall be detectable in the system at any control setting. Depending upon the proximity of a local radio station or upon the cable configuration of the system, RF oscillation or leakage may be a problem and the AV contractor shall be prepared to install a RF low pass filter appropriately in the system as a final remedy.

4. Cross talk between channels shall be measured with signal equivalent to 1.0 Volts output into one channel with its gain off and the gain of each other channel varied over their full range. Maximum signal leakage at the system output must be equivalent to -70 dB re 1.0 Volt at the pre-amp output at 1 kHz, increasing to -52 dB at 8 kHz.
 5. The general performance of each loudspeaker unit in situ shall be verified by applying pink noise signal at 10.0 Volt level and verifying the specified output SPL at a distance of 1 foot. Normal undistorted sound quality shall be verified by headphone listening at the output of the calibrated system. Each loudspeaker shall also be fed with an oscillator signal at 10.0 Volt level within its intended frequency range, verifying absence or abnormal distortion of rattles due to installation.
 6. The audio system shall be adjusted as specified above in paragraph R entitled "Audio System Processing Adjustments" where minimum requirements for establishing readiness for the substantial completion observation of an audio system are specified.
- E. Projection System Performance Criteria
1. Projected images shall properly fill their respective screens to full size without "cropping" or overshoot.
 2. Projection lenses shall provide distortion free images without color fringing or aberration.
 3. Screen brightness and screen brightness ratio shall reasonably approach the theoretical value based on the projector's specified light output value with the necessary light loss corrections.
- F. All these tests, and any others that the AV contractor may wish for his own satisfaction, shall have been performed and successfully achieved before observation requested. The District may request repetition and demonstration during observation of certain of these tests or other critical tests if problems become apparent. If specifications are not met, further observations will be at the AV contractor's expense.

3.3 DEMONSTRATION AND ACCEPTANCE TESTING

- A. Substantial Completion Observation
1. The AV contractor shall file a written notice with the District when all of the aids to use described in paragraph 1.8 above entitled "Submittals", above, have been submitted for approval, all tests described in paragraph 3.2 above entitled "System Performance Tests", are complete and the test reports have been submitted for review and approval and the systems and sub-systems are ready for the Substantial Completion Observation.
 2. The AV contractor shall be prepared to demonstrate the overall system performance including but not limited to functionality, control system programming, operation, optics performance and Digital Signal Processing software control (where applicable). The AV contractor shall be prepared to demonstrate proper gain structure and that base line EQ (equalization of uniform frequency response) settings and delay filters (time alignment) have been set. In addition, the Substantial Completion Observation of the systems may include repetition or demonstration of any or all of the tests described in paragraph 3.2 above entitled "System Performance Tests" above or other critical tests if problems become apparent and the specifications are not met. After the Substantial Completion Observation, written notice noting whether the systems meet the criteria set forth in the General Conditions for Substantial Completion, along with a list of items for the AV contractor to correct shall be provided to the AV contractor.
 3. In the event that the systems are found not to be Substantially Complete, all of the costs including fees, travel and living expenses in connection with subsequent observations or



corrective work shall be borne solely by the AV contractor. This includes new problems that arise during the course of the subsequent observations.

B. Acceptance Observation

1. After the systems have been certified as Substantially Complete, and the AV contractor has filed written notice with the District that the corrections ordered, have been completed, a Final Acceptance Observation shall be scheduled.
2. During the Final Acceptance Observation of the systems repetition or demonstration of any of the tests described in paragraph 3.2 above entitled "System Performance Tests", above, or other critical tests if problems become apparent and the specifications are not met, may be requested.
3. Assist in performing final system adjustments and acceptance tests. Provide all labor, materials and tools necessary for these tests and adjustments. Provide all necessary test equipment to complete the tests.
4. Budget 24 working hours for the performance of these tests and adjustments with the District. If final acceptance is delayed beyond this period because the installation is not in proper working order or is incomplete, the AV Contractor shall pay for all additional time and expenses for any resultant extension or re-scheduling of the acceptance testing period.
5. Any measurements of frequency response, distortion, noise or other characteristics and any adjustments deemed necessary may be performed on any item or group of items, including re-orientation of loudspeakers, to insure optimum performance of the system.
6. In the event that the corrections have not been completed to the satisfaction of the District, or new problems arise at the time of the Acceptance Observation, all costs including consulting fees, travel and living expenses in connection with subsequent observations or corrective work shall be borne solely by the AV contractor.

C. Acceptance

1. After observations and tests indicate that the entire AV system and sub systems as specified herein and indicated on the drawings are in total compliance with the drawings and specifications, a letter indicating said compliance shall be issued.
2. Acceptance of the system shall be accomplished as described in the General Conditions.
3. Final acceptance of the installation will be granted when it is clear to the District and the Architect that the following conditions have been met:
 - a. All fixed equipment has been furnished and installed according to the drawings and specifications.
 - b. All portable equipment has been turned over to the District.
 - c. All equipment and installation have been tested and shown to perform as specified.
 - d. All instruction manuals, software source code and as-built documentation have been completed and delivered to the District.
 - e. All wall-mounted diagrams are installed to the satisfaction of the District.
4. The Warranty period will begin only when all of the above listed items have been performed to the satisfaction of the Architect and District.

D. TRAINING

1. Submit all training materials to the District for approval prior to scheduling training sessions.
2. Provide 24 hours of hands on training practical operation of the system to the District. Address in the training, the general configuration of the system, basic functionality, correct operation procedures, routine maintenance and upkeep.
3. Provide 4 hours of follow-up training within 3 months of the initial training to review aspects of the original training and provide instruction on specific troubleshooting issues the District raises during the training.
4. Record video and audio of each unique training session and provide electronic copies to the District.

END OF SECTION 27 41 16

SECTION 27 51 00
ASSISTIVE LISTENING SYSTEMS (ALS)

PART 1 - GENERAL

1.1 SUMMARY

- A. The work includes the provision of Assistive Listening Systems (ALS) as part of the building project.
- B. The fixed ALS shall function with the voice reinforcement systems to be installed by the Audiovisual Contractor or Owner.
- C. In the absence of fixed ALS, portable ALS shall be provided to the Owner, where specified.
- D. Reference California Building Code (CBC) 2019 sections 11B-219 and 11B-706.
- E. Scope of Work: The work shall consist of the design, provision, termination, testing, and documentation of a complete and fully functional ALS. The instructions in this section are specific to the ALS installations and should be read in conjunction with other contract documents as applicable.
- F. Deliverables: Prior to ordering materials or commencing any construction activities, the contractor shall provide the Owner with a complete bill of materials, including all quantities of components, devices, equipment, and wiring required to complete this work.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. ALS equipment to be manufactured by Listen Technologies, no equal (Sole Source), no equal (Sole Source)
- B. Portable Systems: Provide a minimum of 2 complete systems per building with accessories as described below. More may be required per specific building project. Refer to Construction Project Management or Architect for criteria.
- C. Fixed/Permanent Systems: Provide one fixed systems for each room with occupancy levels of 50 seats or greater as per ADA guidelines.
- D. Portable ALS Equipment
 - 1. Provide the following Listen Technologies FM equipment for operation with the fixed voice reinforcement systems or portable systems as described below.
 - 2. Transmitter/receiver set product – Listen Technologies # LS-06 including charging case.
 - 3. 1 transmitter and microphone and 7 receiver units and headsets.
 - 4. Portable charging carrying case.
 - 5. The receiver shall have 57 user-selectable, 72MHz FCC compliant, approved channels.
 - 6. Provide for Each Portable Transmitter:
 - a. One Pair of NIMH Battery #LA362 or equal
 - b. Lavalier Microphone #LA261 or equal
 - c. Omni Conferencing Microphone #LA277 or equal
 - d. Line/Mic Y Cable #LA263 or equal
- E. Fixed ALS Equipment
 - 1. Provide Listen Technologies digital FM equipment for operation with the fixed voice reinforcement systems only as described below.
 - 2. Base Station #LT-800-072 for fixed installations only with the following capabilities:
 - 3. The receiver shall have 57 user-selectable, 72MHz FCC compliant, approved channels.
 - 4. The receiver shall have on/off, FM volume, Aux volume, Monitor volume, test tone on/off,, Super Quiet Companding Technology on/off, Contour and channel up/down controls and an FM reception LED on the front panel. The front panel shall include a 2-digit channel LED display.
 - 5. The receiver must have installer controls and ports on the back panel which include: antenna port; transmitter power settings; (2) mix outputs; (2) unbalanced audio inputs, selectable between +10 dBu and -10 dBu; (1) balanced XLR/¼” audio input, selectable between microphone, microphone with phantom power, and line level; and a separate DC jack to power the transmitter.

6. The channel display shall have an indicator light illuminated when the main power is off. The size of the receiver must be 20.3 (W) x 1.75 (H) x 20 (D) cm/8.0 (W) x 1.75 (H) x 8.0 (D) in. and weigh 1.4kg/3lbs.
7. The receiver must operate on 72MHz band, or other operating band approved by FCC for assistive listening devices.
- F. Miscellaneous transmitter equipment to include the following:
 1. Transmitter Antenna – provide a standard or large area antenna as required to generate a signal to receivers located at any point in the instructional space covered by the dedicated transmitter.
 2. Accessories:
 - a. Provide the following accessories for operation with the fixed and portable systems only as described below.
- G. Provide for each system (both portable and fixed):
 1. Provide for Each Receiver:
 - a. Dual Earbud #LA-162 with one package of replacement cushions (LA-163)
 - b. One Pair of NIMH Battery #LA362 or equal
 - c. One induction neck loop #LA166 or equal
- H. Provide for each system (both portable and fixed):
 1. Charger #LA-321 with the following capabilities:
 - a. The charger must be capable of storing or recharging up to 8 transmitters or receivers at once.
 - b. The charger must have an external UL- and CSA-approved wall transformer that plugs directly into the charging unit itself. It must have a pocket to contain the power wall transformer during storage. There must be no on/off switch.
 - c. The charging circuitry must be fully automatic and be capable of recharging the transmitter/receiver batteries in 14 hours maximum when 500mA/Hr batteries are used.
 - d. The charger must be capable of recharging NiCad batteries without the need for removal of the batteries from the transmitter/receiver.
 - e. The charger must have a large, foam-lined storage space for accessories, a locking lid, and a handle
- I. Wireless Networked Listening System
 1. Provide Listen Technologies ListenEVERYWHERE #LW-100P-02 appliance based on required application (single-space use or multi-channel, multi-room usage) for network-based audio streaming over personal device as a supplemental component for ALS compliancy and for individual device listening experience.
 2. Connect server(s) to the data network that will be available for use by appropriate occupant. Coordinate network requirements with Owner IT Department.
 3. Interface server appliance in parallel with audio output channel in room shared with ALS equipment.
 4. Provide (if applicable) Listen Technologies #LW-202 venue awareness kit for usage and signage purposes. Coordinate on project for specific signage information along with required ALS signage package for instruction on connecting to the dedicated ListenWiFi app for portable smart devices.
 5. Coordinate with building Administration and Owner IT Department for the smart app display screen and channel identification or room number as applicable.
 6. Provide Listen Technologies #LW-100P-02 two-channel monaural Wi-Fi server appliance in larger auditoria and event spaces (Gymnasiums, Divisible or large Multi-Purpose Rooms, External Venues, Larger Lecture Spaces, etc.).

2.2 ACCESSORIES

- A. Provide the following accessories for operation with the fixed and portable systems only as described below.
 1. Provide for Each Receiver:
 - a. Dual Earbud #LA-162 with one package of replacement cushions (LA-163)
 - b. One Pair of NIMH Battery #LA362 or equal

2. Provide for Each Portable Transmitter:
 - a. One Pair of NIMH Battery #LA362 or equal
 - b. Lavalier Microphone #LA261 or equal
 - c. Omni Conferencing Microphone #LA277 or equal
 - d. Line/Mic Y Cable #LA263 or equal
3. Provide for each system (both portable and fixed):
 - a. Charger #LA-321 with the following capabilities:
 - 1) The charger must be capable of storing or recharging up to 8 transmitters or receivers at once.
 - 2) The charger must have an external UL- and CSA-approved wall transformer that plugs directly into the charging unit itself. It must have a pocket to contain the power wall transformer during storage. There must be no on/off switch.
 - 3) The charging circuitry must be fully automatic and be capable of recharging the transmitter/receiver batteries in 14 hours maximum when 500mA/Hr batteries are used.
 - 4) The charger must be capable of recharging NiCad batteries without the need for removal of the batteries from the transmitter/receiver.
 - 5) The charger must have a large, foam-lined storage space for accessories, a locking lid, and a handle
 - b. Provide one induction neck loop #LA166 or equal

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Assistive Listening transmitters shall be provided to the Owner in the following rooms:
 1. Each room with 50 seats or more shall receive a fixed and installed ALS transmitter system.
 2. Each room with a sound reinforcement system shall receive a fixed and installed ALS transmitter system.
 3. If multiple transmitters are specified within a facility, it is recommended that the adjacent transmitter channels be at least 300MHz apart. If no interference, the following channels are recommended; 2C, 2D, 2E, 2F, 2G, 2H, 2J, 2K, 2L.
- B. Assistive Listening receivers shall be provided to the Owner as follows:
 1. For sound reinforcing, per CBC Section 1104B.2, each room with 50 or more seats shall receive a quantity of ALS receivers that equals at least 4% of the number of seats in the room (rounding up to the nearest integer), but no less than two. (I.e. A classroom of 80 would receive 4 receivers.)
 2. Each portable system will be provided with 4 receivers
- C. Fixed ALS transmitters will be located at AV Equipment rack positions dedicated to each room listed above, or where applicable in portable AV racks.
- D. Portable ALS transmitters and receivers will be given to the Owner for distribution.
- E. Equipment to be installed in accordance with manufacturer's instructions.

3.2 TESTING

- A. Following the installation of transmitters and antenna, each transmitter and receiver will be tested.
- B. Transmitters shall support signal distribution at all specified channels at any position in the instructional room to which its use is dedicated.
- C. Receivers shall be tested to verify function as specified by manufacturer.
- D. This is to be done before hand-off to College or to the College's representative for remaining Audiovisual System integration to test for short-life product failures.
- E. All transmitter/receiver sets will be tested simultaneously to ensure no channel conflicts occur.

3.3 WARRANTY

- A. Manufacturer's standard warranty.



- B. Contractor to provide all completed product warranty cards or register product with product manufacturer for the College.

END OF SECTION 27 51 00



SECTION 27 51 13
NETWORKED PAGING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Conditions and Requirements, Special Provisions, of any larger body of specifications, of which this specification may be a part, are hereby made a part of this specification.
- B. Networked paging system is included on only the building exterior. Interior are covered with the campus voice evacuation system.

1.2 SUMMARY

- A. This specification includes speakers, network audio components and cabling requirements for an IP based networked paging and announcement system.

1.3 REFERENCES

- A. UL6500 - Standard for Audio/Video and Musical Instrument Apparatus for Household, Commercial and Similar General Use
- B. UL1480 - Standard for Safety Speakers for Emergency, and Commercial and Professional Use
- C. ASTM E 1374-02 - Standard Guide for Open Office Acoustics and Applicable ASTM Standards
- D. ASTM E 1573-02 - Standard Test Method for Evaluating Masking Sound in Open Office Using a Weighted and One-Third Octave Band Sound Pressure Levels
- E. ASTM E 1130-02e1 - Standard Test Method for Objective Measurement of Speech Privacy in Open Offices Using Articulation Index
- F. Divisions 27 & 28

1.4 PERFORMANCE REQUIREMENTS

- A. General Performance
 - 1. The intent of this specification is to provide a hybrid IP and 70v external paging system. Building speakers must IP based and have the ability to control each and every speaker individually. Outside and gathering areas must be grouped together in a logical manor and homerun back to the closest telecom room.
 - a. Speakers located in common areas and outside must be grouped together in a logical manor.
 - 2. The basic system configuration shall provide multi-channel, coherent paging for networked speakers.
- B. Paging Performance
 - 1. The system shall accommodate equalization of all paging signals.
 - 2. The paging volume shall be digitally adjustable in 0.5 dBA increments over a range of 35 dBA to 85 dBA @ 1m.
 - 3. The paging processor shall be compliant with SingleWire Informacast™ systems.
- C. Automatic Level Control
 - 1. The system shall provide a timer function allowing network audio levels to be automatically controlled according to a calendar-based user defined schedule.
 - 2. The system shall provide automatic daylight-saving time adjustments.
 - 3. The system shall allow independent timer multiple schedules for each day of the week.
 - 4. The system shall allow configurable levels of volume adjustment and attenuation. The control processor shall be compliant with SingleWire InformaCast™ systems.
- D. Network Performance
 - 1. All network switches shall comply with MCCCCD standards for Data Communications.
 - 2. The system shall be capable of ensuring that the expected network devices are present and communicating properly and identify network devices that are not communicating properly.

3. The network control software shall be capable of monitoring and displaying the current settings for all network devices and speakers.
4. The system shall be capable of generating detailed reports of all system settings down to the level of individual network devices and speakers.
5. Speaker controllers shall be capable of equalization, level adjustment and network audio channel selection for every channel.
6. Speakers shall confirm to the following:
 - a. Dynamic or Static IP Addressing.
 - b. IEEE802.3 10/100Base-T Ethernet.
 - c. IEEE 802.11AT Compliant.
 - d. VoIP Standard Audio: G.711 u-law/a-law (64 kbit/s) or G.722 Wideband Audio (64 kbit/s).
 - e. Auto Provisioning: DHCP Option 66, 150, or TFTP Server or DHCP Option 72 for HTTP Server.
 - f. Auto Registration: SLP for InformaCast or DHCP Option 72 for SA-Announce or GCK.

1.5 SUBMITTALS

- A. Product Data: Manufacturer's specifications, data sheets and installation instructions.
- B. Network Design: Schematics of the network showing quantity and location of network components and related cabling.
- C. Warranty Documents: Warranty documents covering the system components.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum of 10 years manufacturing paging systems.
- B. Installer Qualifications: Approved by manufacturer representative and are trained with the specified products or have demonstrated experience with the installation of similar products.
- C. Uses industry standard network switches and cabling and methodology following the Section 27 10 00 – Data Communications.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Protect from moisture during shipping, storage and handling.
- B. Deliver in manufacturer's original unopened and undamaged packages with manufacturer's labels legible and intact.
- C. Inspect manufacturer's packages upon receipt.
- D. Protect from damage and theft during storage and staging until installation.
- E. Handle packages carefully.

1.8 WARRANTY AND MAINTENANCE

- A. Provide a written warranty that products installed shall be free from defects in parts or assembly for a 3-year period from date of installation.

1.9 CONFIDENTIALITY STATEMENT

- A. Confidentiality: Drawings and specifications involving the network paging system represent a vulnerability to the security of the facility and are to be considered confidential information.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: compliant with the Singlewire InformaCast™ system.
- B. Substitutions: Networked paging systems meeting the addressability criteria may be substituted. Systems utilizing primary and secondary network devices where the secondary device is not individually controllable are not acceptable.
- C. Networked paging system is included on only the building exterior. Interior are covered with the campus voice evacuation system.



2.2 SYSTEM COMPONENTS

- A. General System Overview: The paging system shall be a PoE networked system. The system shall be comprised of:
 - 1. VoIP phone or paging microphone
 - 2. IP-to-Analog Controller and Mixer/Amplifier(s) as required for legacy equipment interface (existing building conditions only)
 - 3. Loudspeaker assemblies
 - 4. PoE network switch(es)
 - 5. Cable assemblies
 - 6. Dimensions: Width 19.0 inches Height 1.75 inches; 1 RU
 - 7. Network communication components
 - 8. Device shall be ETL listed to conform to UL60065
- B. Each external wall and ceiling speaker assembly shall provide:
 - 1. A networked connection to the speaker controller with strain relief
 - 2. An acoustically damped vandal-resistant enclosure
 - 3. Eye-bolt for single point suspension and upward facing speaker orientation
 - 4. Speaker sensitivity: 90 dBA@1Watt, 1 meter pink noise
 - 5. Speaker power rating: 10 watts RMS
 - 6. Speaker frequency response: 100-10,000 Hz
 - 7. Magnet size: 20 oz.
 - 8. Device shall be ETL listed to conform to UL1480, UL2043, CSA C22.2 60065
 - 9. Approved speaker manufacturers include Atlas IED, Valcom, Cisco, etc.
- C. Each internal wall and ceiling speaker assembly shall provide:
 - 1. A networked connection to the speaker controller with strain relief
 - 2. An acoustically damped enclosure (plenum-rated as required) or A.C.T. suspended ceiling enclosure and speaker combined assembly
 - 3. Eye-bolt for single point suspension and upward facing speaker orientation
 - 4. Speaker sensitivity: 90 dBA@1Watt, 1 meter pink noise
 - 5. Speaker power rating: 10 watts RMS
 - 6. Speaker frequency response: 100-10,000 Hz
 - 7. Magnet size: 20 oz.
 - 8. Device shall be ETL listed to conform to UL1480, UL2043, CSA C22.2 60065
 - 9. Approved speaker manufacturers include Atlas IED, Valcom, Cisco, etc.
- D. IP Gateway (for bridging existing or new analog exterior speakers):
 - 1. Network connectivity of digital to analog gateway to connect to the MCCCDC network and paging system.
 - 2. Connect to external analog audio amplifier to support the external analog speakers.
- E. Cable assemblies:
 - 1. Provide power, audio and control signals over standard plenum rated CAT-6 with RJ-45 connectors.
 - 2. For connection to new speakers, provide CAT-6 cable to each speaker home-run to closest telecom (BDF/IDF closet)
 - 3. For connection to legacy speakers, provide speaker connections to speaker controllers with two conductors, 18 A.W.G. copper stranded, plenum rated wire.
- F. PoE network switches shall be:
 - 1. OFCI Professional quality PoE IEEE 802.3af-2003 compliant network switches as required. CAT-5 with RJ-45 connectors. Typical switch: Cisco 24 port PoE

2.3 SOFTWARE CONTROL

- A. The software shall provide:
 - 1. The ability to adjust any individual speaker without affecting adjacent speakers

2. The ability to define and adjust groups of speakers
 3. Paging volume and equalization
 4. The ability to route and mix network audio channels to any individual speaker
 5. The ability to create and adjust zones for paging and music
 6. Reporting of all system settings
 7. Backup and restore functions for all system settings
 8. Network diagnostics
 9. Panic button integration
 10. 911 Alerting
 11. Building lockdown, evacuation & emergency notification
 12. Pre-recorded announcements
- B. In addition to the provided software, all system functions shall be able to monitored via SNMP (simple network management protocol) to facilitate integration into other network monitoring solutions.

PART 3 - EXECUTION

3.1 NETWORK DESIGN

- A. Design network according to manufacturer's and MCCCDC's Section 27 10 00 – Data Communications specifications.

3.2 SITE CONDITIONS

- A. Verify facility conditions are suitable for the system installation.
- B. Verify the facility is constructed according to plans including wall locations, ceiling types, plenum barriers and plenum heights.
- C. Ensure sufficient space and power for centrally located components is available as per plan and manufacturer's specifications.

3.3 PERMITS

- A. Obtain necessary permits for installation work.

3.4 INSTALLATION

- A. Follow all applicable codes for the area.
- B. Follow the system design for location of speaker controllers, speakers and wiring.
- C. Record any necessary changes to the system design on the plan
- D. Follow MCCCDC's Division 27 10 00 – Data Communications

3.5 FIELD QUALITY CONTROL

- A. Ensure that distance between the top of the loudspeaker and the deck meets manufacturer's minimum specifications
- B. Ensure that loudspeakers are not obstructed
- C. Ensure cables are properly supported and securely terminated

3.6 NETWORK CONFIGURATION AND ADJUSTMENT

- A. Follow manufacturer's recommendations for system settings

3.7 TESTING AND REPORTING

- A. Test covered areas for desired spectrum and spatial uniformity
- B. Verify that all system audio functions and timers are correctly configured per plan
- C. Provide data cable certifications per Section 27 10 00 – Data Communications

3.8 AS-BUILTS AND DOCUMENTATION

- A. Provide detailed drawings showing all speaker controllers and speaker Identifications. Drawings shall include signal line diagrams showing the device routing, connections and labeling for easy circuit tracing.



- B. Provide a printed report detailing system settings.
- C. Provide all instruction and installation documents in PDF format.
- D. Provide all close-out and warranty information including product serial number listing. Data to be provided in editable spreadsheet table (Microsoft Excel™, etc.).
- E. Provide a table of all networked components within the provided system documenting network IP address and information (device name, MAC address, device serial number, connected network port number, etc.). Data to be provided in editable spreadsheet table (Microsoft Excel™, etc.).
- F. Provide detailed documentation for speaker/channel levels and configuration.

END OF SECTION 27 51 13



**SECTION 27 53 13
CLOCK SYSTEMS**

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS AND SCOPE

- A. Furnish and install a complete new GPS or NTP Wireless Synchronized Clock system using the Innovation Wireless KRONsync System, SOLE SOURCE. Specify GPS or NTP time source.
- B. All Bids shall be based on Innovations Wireless' product specification as contained herein.

1.2 SUMMARY

- A. GPS, NTP Wireless Transmission System
 - 1. Transmitter with GPS Receiver or NTP (Network Time Protocol).
 - 2. Secondary Transmitter
- B. Wireless Receiving Devices
 - 1. Digital Clocks – AC Powered

1.3 RELATED DIVISIONS AND SECTIONS

- A. Division 26- Electrical 120V grounded outlet required for Transmitter, AC powered Analog Clocks, and Digital Display Clocks.

1.4 REFERENCES

- A. Innovation Wireless Operations Manual and Associated drawings.
- B. National Fire Protection Agency (NFPA) – 70, National Electric Code 2005

1.5 DEFINITIONS

- A. (GPS): Global Positioning System, a worldwide system that employs 24 orbiting satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits atomic time (UTC).
- B. (NTP): Network Time Protocol, Short for *Network Time Protocol*, an Internet standard protocol (built on top of TCP/IP) that assures accurate synchronization to the millisecond of computer clock times in a network of computers. Based on UTC, NTP synchronizes client workstation clocks to the U.S. Naval Observatory Master Clocks in Washington, DC and Colorado Springs CO. Running as a continuous background client program on a computer, NTP sends periodic time requests to servers, obtaining server time stamps and using them to adjust computers clocks.

1.6 SUBMITTALS

- A. System Product Data: Submit all data for each component, describing its operational and physical characteristics along with the method of installation. Submit a brochure showing all available colors and dimensions of clocks.
- B. Operating License: The system must operate in accordance with a "Radio Station Authorization" form FCC 601 granted by the Federal Communication Commission (FCC). Submit evidence of application for operating license prior to installing equipment. Furnish the license, or if the license has not been received, a copy of the application for the license, to the Owner prior to operating the equipment. Upon receipt of License, deliver original license to Owner.
- C. Samples: Submit one clock for approval. The approved sample is to be tagged and installed as part of the final operating system.
- D. Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions.
- E. Schematic indicating the location of the transmitter(s) and all clocks must be submitted by owner prior to installation.



1.7 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer: Company specializing in manufacturing of timekeeping products with a minimum of 30 continuous years of documented experience.
 - 2. Installer: Company with documented experience in the installation of commercial timekeeping systems.
- B. Permits: Obtain FCC license for Transmitter authorization

1.8 REGULATORY REQUIREMENTS

- A. Equipment and components furnished shall be manufacturer's latest model.
- B. Master Transmitter and receiver shall comply with Part 90 of FCC rules, as follows:
 - 1. This device must not cause harmful interference and must accept interference received, including interference that may result in undesirable operation.
 - 2. Transmitter frequency shall be governed by FCC Part 90.35.
 - 3. Transmitter output power shall be governed by FCC Parts 90 and 74.
- C. System shall be installed in compliance with local and state authorities having jurisdiction.
- D. The end user must acquire an operating license, or "Radio Station Authorization" that will be granted by the FCC. This permits the end user to legally operate this Wireless system.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Deliver all components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number, and other related information.
- B. Store equipment in finished building, unopened containers until ready for installation.

1.10 PROJECT FIELD CONDITIONS

- A. Clocks shall not be installed until painting and other finish work in each room is complete.
- B. Coordinate installation of GPS receiver to an exterior wall or to an access point on the roof. GPS receiver must be mounted and wire ran back to the Transmitter and all entrances to the building made watertight.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Innovation Wireless: KRONOsinc Wireless Time System
11869 Teale Street, Culver City, CA 90230
Phone: 1-888-559-5565
Fax: 301-482-3480
Website: www.InnovationWireless.com

2.2 SYSTEM DESCRIPTION AND OPERATION

- A. The KRONOsinc Wireless GPS, NTP timekeeping system consists of a master Transmitter located on the inside the building, a GPS receiver mounted on the roof, exterior of the building or window, or NTP receiver box connected via an RJ45 Ethernet cable from an in-house computer network to the transmitter, along with analog or digital clocks, and accessories. Once operational, the transmitter shall keep all system clocks synchronized to the second all day, each day, everyday.
- B. System shall synchronize all clocks to each other. System shall utilize GPS or NTP technology to provide atomic time to components.
- C. System shall not require hard wiring for its components except for AC power. Analog clocks may be battery operated for full portability if required.
- D. Clocks shall automatically adjust for Daylight Saving Time per the Daylight Saving time settings in the Master Clock.
- E. Analog Clocks shall synchronize to +/- 1 second of the master clock displayed time.



- F. The system has an internal clock that will continuously be updated by the GPS or NTP. If a GPS or NTP failure were to occur, the clocks would continue to be synchronized to the internal clock and would not deviate from one another. Once GPS or NTP time is restored, all clocks would once again be synchronized.
- G. The system has a fail safe design so that if a power interruption were to occur, the clocks will continue to operate. Upon the restoration of power, the transmitter will once again communicate with the clocks and normal operation will resume.
- H. Analog clocks shall require 2 "D" cell batteries and be portable and if AC powered, wired to end user specifications.
- I. System shall be 100% programmable from the front operation panel with lights that indicate power status, and GPS or NTP reception.
- J. System programming for Time Zone, Frequency, 12 or 24 hour operation and DST on/off must be programmable from the front of transmitter to avoid system movement.

2.3 EQUIPMENT

- A. Master Wireless Transmitter: The Transmitter is to be installed in an internal location, and can be mounted as a stand alone unit, or as part of a rack system. The LED and associated buttons on front of Transmitter will allow for the programming and display of the following operating features:
 - 1. Master Transmitter: KRONOsyc Model # 101005 shall have an internal clock which will guarantee that the operation of the clocks will continue to be synchronized in the event of a temporary GPS failure, SOLE SOURCE.
 - 2. Time Zones: Display and programming must allow for the selection and display of Time zones for all of North America: Eastern, Central, Mountain, Pacific, Alaska and Hawaii. It must also allow for all international time zone options.
 - 3. Daylight Saving Time: Transmitter must allow for automatic adjustment of the system, allowing it to be active or inactive.
 - 4. 12hr or 24hr Operation: System must allow for programming of desired method of operation on the face of the transmitter.
 - 5. Frequency Range: 467.2125- 467.4375 MHz.
 - 6. Programming: All programming of operating features must occur on the front of the Transmitter and all changes must be able to be viewed on the digital display as the changes are being made.
 - 7. GPS Receiver: GPS roof mounted receiver comes with an attached 15' cable (3m). The GPS receiver will be water tight and has a built in receiver. Additional extension cable lengths of 25' 50' and 100' are available. A GPS mounting bracket is provided for secure roof mount or side wall installation.
 - a. NTP Receiver: Receiver box comes with a 20" Ethernet cable.
 - b. Transmitter Power: 5 watt.
 - c. Transmission Range: Up to 2 miles radius (transmitter power dependent)
 - d. Operating Range: 32 degrees F to 158 degrees F (0 degrees C. to 70 degrees C.)
 - e. Radio Technology: Narrowband FM, 12.5 KHz bandwidth
 - f. Antenna: Shall be used for indoor applications and attached to the rear of the transmitter. No external antenna required.
 - g. Power Supply: (included with transmitter)
 - 1) Input: 120-volt AC 50/60 Hz
 - 2) Output: 12-volt DC, 3 Amps
 - h. Recommended: Surge Protector/Battery Backup:
 - 1) Input: 120-volt AC 60 Hz +/-1 Hz.
 - 2) Output: 120-volt AC, 550VA, 300 watts
 - 3) Surge Energy Rating: 365 joules
 - 8. Analogue Clocks: Analog clocks will be battery operated using 2 "D" cell batteries provided by the manufacturer or AC power based on specification. All clocks shall be wall mounted. Clocks shall have ABS (polystyrene), Wood, or Metal Frame and polycarbonate or glass lens. (other options



available). Face shall be white or antique. Hour and minute hands shall be black, second hand is red.

- a. Clock features:
 - 1) Clocks shall automatically update from the transmitter 6 times a day. 2:00, 6:00, 10:00 AM/PM. Use manufacturers provided "D" cell batteries or AC power adapter. Logo Clock Faces: Analog clocks shall bear the Owner's logo as indicated. Custom logo's are available as an option.
 - 2) Additional finishes and colors available.
 - 3) Automatically adjusts for Daylight Savings Time, if option is selected.
 - 4) Clocks will keep operating in synchronized mode if GPS or NTP signal is lost due to GPS or NTP failure. Once signal is re-acquired, clocks will resume GPS or NTP time synchronization.
 - 5) Clocks will keep operating as quartz based clocks if there is a transmitter malfunction.
 - 6) Clock Models: (Battery/Electric)
 - a) 13" Standard Model # 210001 #312001 120VAC, #311001 24VAC
 - b) 16" Standard Model # 220001 #322001 120VAC, #321001 24 VAC
 - c) Wood Clocks: (see brochure or website for specific model)
 - d) Brushed Aluminum Clocks: (see brochure or website for specific model)
 - e) Digital Display Clocks: (see brochure or website for specific model)
 - f) Security Brackets: Built in to rear of clocks for wall mounting
- b. Digital Clocks must be able to receive synchronized time signals from the Innovation Wireless KRONOsync Transmitter and possess the same operating features as all Analog clocks.
- c. Wire guards: Provided to protect clocks in harsh environments:
 - 1) 16 x 16 inch Wire Guard for 13-inch diameter analogue clocks Model #104001.
 - 2) 19 x 19-inch Wire Guard for 16-inch diameter analogue clocks Model #104002

2.4 SYSTEM OPERATION AND STARTUP

- A. Transmission System shall receive Atomic Time information every second from the GPS receiver which is mounted with an unobstructed view of the sky and is connected to the system master transmitter, or the NTP receiver mounted on and connected to transmitter. Upon power up and receipt of GPS or NTP time, the Transmitter will then transmit GPS or NTP synchronized time to all receiving devices programmed to the system frequency. The transmitter and all receiving devices will monitor receipt of GPS or NTP time and remain synchronized.
- B. Wireless Master Transmitter Operation
 1. When power is first applied to the master transmitter, the power light will flash and it will search for a valid GPS or NTP signal and upon receipt, it will set the internal clock of the transmitter. The transmitter will update its internal clock whenever it receives a valid time signal from the GPS or NTP receiver. It shall transmit GPS or NTP time 3 times per minute to all receiving devices.
- C. Analog Clock Operation
 1. For battery clocks, insert the two supplied "D" cell batteries. The receiver will search for a signal from the transmitter by scanning all frequencies. Upon receipt of the signal, the clock will store the frequency in memory and set the clock to the exact second of the transmitter. The clocks will locate the position of the hands and automatically set them to be in perfect synchronization to the Master Transmitter. The clock hands will move in a quick "clockwise" motion until they get to the transmitter time.
- D. Digital Clock Operation
 1. Connect the DC adapter (supplied with each digital clock) to the appropriate power source. The built in receiver will search for a signal from the transmitter by scanning all frequencies. Upon receipt of signal confirmation, the digital clock will store the frequency in its non-volatile memory and synchronize to the exact time of transmitter.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.
- B. Verify that 120-volt electrical outlet is located within 6 feet of location of transmitter and the outlet is operational and properly grounded.
- C. Verify that all 120-volt electrical outlets for the AC powered clocks are located at the exact installation point and the outlet is operational and properly grounded.

3.2 SYSTEM INSTALLATION

- A. Install in accordance with manufacturer's installation manual furnished with system.
- B. The GPS receiver shall be mounted on the outside wall of the building, roof, or inside window. In all cases the GPS unit must have a clear view of the sky. If mounted on exterior side wall, there is to be no overhanging structure that can block its view of the sky. If located on the roof, it must be at a height that will prevent it from contacting potentially standing water, or buried under snow. If inside window mounted, the class cannot contain chemical shielding. (Low E)
- C. The NTP receiver shall be located next to or sit on top of the Transmitter. Connect the RJ45 Ethernet cable from your computer network to back of the NTP receiver. Connect the NTP receiver to the Transmitter with the supplied cable. The NTP receiver does not require individual power supply.

3.3 CLEANING

- A. Prior to final acceptance, clean exposed surfaces of all system components, using cleaning methods recommended by the manufacturer. Remove any labels from the faces of the clocks.

3.4 MANUFACTURER SERVICES/DEMONSTRATION

- A. Provide technical assistance to owner's representatives on functioning of the system and ongoing operation requirements. Use operations manual, or call 1-888-559-5565.

3.5 FIELD INSPECTION

- A. Prior to final acceptance, inspect entire system to ensure proper functioning and synchronization of components and replace any parts found defective. Contact Innovation Wireless at 1-888-559-5565.

END OF SECTION 27 53 13



SECTION 28 13 00
ELECTRONIC ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This specification section covers the furnishing and installation of a complete expansion to a campus-wide, low-voltage, electronic access control system (EACS) at MiraCosta.
- B. Contractor shall furnish and install access control hardware devices, mounting brackets, power supplies, switches, controls, consoles, and other components of the system as shown and specified.
- C. Contractor shall furnish and install access control related software to allow this system expansion. Software includes required license addition for access control readers and electrified portals workstations.
- D. Refer to responsibility matrix on security drawings for scope delineation.

1.2 PRECEDENCE

- A. Obtain, read, and comply with General Conditions and applicable sub-sections of the contract specifications. Where a discrepancy may exist between any applicable sub-section and directions as contained herein, this section shall govern.

1.3 GENERAL CONDITIONS

- A. In accordance with Section 28 05 00, Security System General Requirements

1.4 RELATED WORK

- A. Drawings and general provisions of the Contract, including General Conditions and Standard Guidelines referenced in Division 01 Summary Section, apply to this Section.
- B. In accordance with Division 27.
- C. In accordance with Division 28.
- D. Applicable Publications

1.5 SHOP DRAWINGS & EQUIPMENT SUBMITTAL

- A. In accordance with Division 28.

1.6 OPERATING AND MAINTENANCE MANUALS

- A. In accordance with Division 28.

1.7 SERVICE AND MAINTENANCE

- A. In accordance with Division 28.

1.8 TRAINING

- A. In accordance with Division 28.

1.9 WARRANTY

- A. In accordance with Division 28.

1.10 TECHNICAL REQUIREMENTS, ELECTRONIC ACCESS CONTROL SYSTEM (EACS)

- A. General
 - 1. The following information is provided to establish required system performance for the complete operating EACS access control system. Contractor shall provide equipment, wiring and software programming at all sites as necessary to provide a complete system as described herein and as shown on the drawings.
 - 2. Contractor shall be responsible for providing equipment and software licenses to achieve the specified system performance described herein.



- B. Purpose
 - 1. The electronic access control system is designed to monitor and restrict access to specified areas, and to report on the activity and violations of restricted access in those areas.
- C. Environment
 - 1. The system shall be wholly contained within the MiraCosta Campus. Refer to the drawings and Bid Instructions to determine the scope limitations for this phase of work.
 - 2. Monitoring Post: Existing monitoring post clients are located throughout the MiraCosta campus determined by the Owner. Site monitoring, site configuration, and site-related access privilege management may occur at various locations and require owner coordination.
 - 3. Infrastructure and Connectivity
 - a. Local Sites and Buildings: The EACS workstations and controllers shall reside on the building Local Area Network (LAN) or network segment. Coordinate with the Owner on the provision of LAN ports and network rights for new connections.
- D. Attributes
 - 1. General
 - a. The EACS shall be Lenel Onguard Professional, supporting a sufficient number of access control readers, sufficient number of inputs / outputs, sufficient number of client workstations, and sufficient number of cardholders.
 - b. The system shall comprise electronic access control system field devices located as shown on the drawings and connected to provide a complete and operational system.
 - c. The EACS shall be based on a distributed system of fully intelligent, standalone controllers, operating in a multi-tasking, multi-user environment.
 - 2. Electronic Access Control System Description
 - a. The Electronic Access Control System (EACS) is the key central component for managing physical access control and the bridge between physical and logical access control for this project. The system shall provide a variety of integral functions including the ability to regulate access and egress; provide identification credentials; monitor, track, and interface alarms.
 - b. The EACS shall be able to seamlessly interface with and monitor Controllers, reader interface modules, I/O panels, burglar alarm panels, burglar alarm panel receivers, biometric devices, personal protection devices, intercom systems, fire alarm panels (secondary monitoring only), building management systems and digital video recorders.
 - c. The EACS shall be able to communicate with Controllers via RS-485, RS- 232, TCP-IP/Ethernet and Dial-up via Modem.
 - 3. EACS Software Capabilities: The EACS Software shall support all needed card readers, input points, intrusion detection points, and relay outputs as directed on the security drawings. The EACS database server shall support an unlimited number of cardholders, visitors, and assets limited only by the available memory on the controller. The database server shall also support an unlimited number of system events and System Operator transactions in the history file limited only by available hard disk space. Client Workstations shall be limited only by the limitations of the operating system server software.
 - 4. The Contractor shall incorporate the following application software features and functionality into the work, and configure the system and devices to make use of these and any other features offered by the application software, as required by the Owner.
 - a. Thin client, web server, capable of 2 concurrent connections
 - b. Time Zones
 - c. Access Levels
 - d. Temporary Access Levels
 - e. Access Groups
 - f. Holidays
 - g. First Card Unlock
 - h. Database Segmentation



- i. Field Hardware Communications
 - j. Dual Path Field Hardware Communication
 - k. Multi-Drop Panel Support
 - l. Area Control
 - m. Global Input / Output / Event Linkage
 - n. Cardholder Use Limits
 - o. Extended Individual Strike Times
 - p. Extended Individual Door Held Open Times
 - q. Extended, on Demand, Door Held Open Times
 - r. Elevator Control
 - s. Graphical System Overview Tree
 - t. Alarms:
 - 1) Pre-Alarm
 - 2) Alarm/Event Logging
 - 3) Monitor Zones
 - 4) Alarm/Event Routing
 - 5) Text Instructions
 - 6) Alarm Attributes
 - 7) Alarm-Event Mappings
 - 8) Alarm Masking Groups
 - 9) Input Control Module (ICM)
 - 10) Current Status Indication
 - 11) Color Coding for Alarm Priorities
 - 12) Pre-Defined "Canned" Alarm Acknowledgment Responses
 - 13) Alarm Monitoring – Column Display & Configuration
 - 14) Test Mode
 - 15) Alarm Filtering
 - 16) Alarm Masking
 - 17) On-Line Context Sensitive Help
 - 18) Sorting Capabilities
 - u. Device Group Support
 - v. Scheduling Utility
 - w. Access Control:
 - 1) Denied Access Attempts Counter.
 - 2) Card Reader Time Zone Overrides
 - 3) Card Reader Options
 - x. Manual Control
 - y. VSS Interface
 - z. Real-Time, Dynamic Graphical Maps
5. The Contractor shall add new applications, features, functionality, and options specified herein for the work, and configure the system and devices to make use of these applications, features, functionality, and options, as required by the Owner.
- E. Controllers
- 1. The Controller shall link the EACS Software to all "down-stream" field hardware components. The controller shall provide full distributed processing of access control / Alarm Monitoring rules and operations. A fully loaded and configured controller shall respond in less than one-half (0.5) second to grant or deny access to cardholder.
 - 2. The controller shall continue to function normally (stand-alone) in the event that it loses communication with the EACS software. While in this off-line state, the controller shall make access granted/denied decisions and maintain a log of the events that have occurred. Events shall be



stored in local memory, and then uploaded automatically to the EACS database after communication has been restored.

3. The Lenel Controller shall incorporate the following features
 - a. FCC Part 15, CE, RoHS, UL 294, UL 1076, ULC CSA-C22.2, CAN/ULC-S319-05, cUL/ ORD-C1076
 - b. On-board Ethernet 10/100Base-T port provides up to 8 times greater throughput than serial-to-Ethernet converters.
 - c. DHCP and fixed IP addressing supported.
 - d. DNS device naming through DHCP extended commands
 - e. 6 MB of available on-board, non-volatile flash memory
 - f. Battery-backed, non-volatile storage of 50,000 events
 - g. Firmware stored in flash memory, background download of firmware updates supported
 - h. Supports up to 16 different formats (8 card formats and 8 asset formats)
 - i. Biometric template storage support for Schlage Recognition Systems®, Bioscrypt®, and Identix®.
 - j. Direct connection of Bioscrypt RS-485 devices
 - k. Enhanced anti-passback capabilities
 - l. Up to 32,000 access level permissions
 - m. 255 holidays with grouping, 255 timezones, each with 6 intervals
 - n. Elevator control support for up to 128 floors
 - o. Individual extended held open and strike times (ADA required)
 - p. Up to 9-digit user PIN codes • 20 status LEDs
 - q. 2 dedicated inputs for tamper and power failure status
 - r. 12 or 24 VDC input power
 - s. Advanced Encryption Standard (AES) 128-bit algorithm for communications
- F. Intrusion Detection System (IDS) and Integration
 1. Intrusion panel shall be installed and wired to the EACS system for functionality listed herein.
 - a. Intrusion system consists of:
 - 1) Intrusion Control Panel, keypad, motion detectors, arming readers, door contacts, communication modules and I/O modules.
 - b. Functionality
 - 1) The EACS system shall integrate with the Intrusion control panel to provide separate IDS arming reader installed adjacent to IDS keypad installed.
 - 2) First valid card read of the day from any exterior card reader deactivates the IDS system for the building.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Product Acceptability: The Products section contains lists of acceptable products. If product substitutions are proposed, they must be made based upon a comparison of equivalence to the product specified and compatible with the proposed system. Considerations may include but shall not be limited to functional, physical, aesthetic and/or interface aspects. The Owner shall be the sole judge of whether or not a submitted substitution is deemed to be "equivalent" to that specified. Contractor may not use contractor proprietary interface modules for connections between field devices and controller.
- B. Equipment shall have a UL Listed mark on the product.

2.2 ELECTRONIC ACCESS CONTROL EQUIPMENT

- A. System: Lenel Onguard Professional, Electronic access control system, configured as described herein.
- B. Software



1. Operating System: Microsoft Server 2008, Windows 10, or other standard operating system, as required by the proposed system. Version and configuration shall be as recommended by the manufacturer, based upon compliance with these specifications.
2. Custom/User Configuration: Provide new programming as required to perform alarm, control, interface, map, graphic and database functions described herein.
- C. System Controller Panels: Provide sufficient controllers and input/output boards to meet all requirements of specifications at each building.
 1. Lenel EACS Controller
 - a. All panels will be Lenel LNL-2220 Series controllers with Lenel LNL-1320 (2- reader panels) At wall-mount enclosures, provide boards only mounted to removable backplanes of enclosures.
 - b. Each LNL-2220 panel will be individually connected to the network, and will not be connected to additional panels using RS-485.
 - c. Contractor shall review drawings and specifications with the Owner and Engineer, and may propose changes to the topology of the system based on device layout, where such changes improve performance or functionality of the system. The Owner has final authority as to the final approach for system topology.
 - d. Controller Connectivity
 - 1) Controllers shall support connection to the access control LAN/WAN using TCP/IP protocol, and shall also support connection to the manufacturer's standard data communications protocol (RS-232, RS- 485, or RS-422).
 - 2) Connectivity shall be monitored by the system and report loss of communications and restoral of communications. Controller shall retain in memory events and communicate events during loss of communications to the system upon restoral of communications.
 2. Equipment Modules: Provide reader, input, and output control capacity at each controller location, to meet the requirements of the site configuration.
 - a. Door controller: LNL-1320 Series 3 dual reader interface module
 - b. Remote Input Board: LNL-1100 Series 3 input control module
 - c. Output Board: LNL-1200 Series 3 output control module
- D. Access Control Readers: Provide compliant proximity card readers where shown on the drawings and indicated within these specifications ensuring compatibility with the smart card technology embedded in the cards provided as part of this contract. Card readers shall be "single-package" type, combining controller, electronics, and antenna in one package:
 1. Provide black HID Signo 40 reader, part # 40NKS-00-000000
 - a. Multi-Technology Reader: Multi-technology contactless reader shall read access control data from both 125 kHz and 13.56 MHz contactless smart cards. The multi-technology contactless reader shall be optimally designed for use in access control applications that require reading both 125 kHz Proximity and 13.56 MHz contactless smart cards meeting the following requirements:
 - 1) Compatible with HID 125kHz proximity identification media.
 - 2) Compatible with Secure Mifare and DesFire identification media, including the Configuration allows reader to be enabled to read smart, proximity or both technologies at the same time.
 - 3) Secure access control data exchange between the smart card and the reader utilizing diversified keys and mutual authentication sequences.
 - 4) Optimal read range and read speed for increased access control throughput.
 - 5) Suitable for both indoor and outdoor applications.
 - 6) Customizable behavior for indicator lights and beeper.
 - 7) Multi-technology contactless reader shall comply with the ISO 14443 13.56MHz-related standard.
 - 8) Configurable to read data from any compatible 125 kHz technology simultaneously with 13.56 MHz data.



- 9) Provide the ability to read card access data stored in the secure access control sector/application area of the ISO 14443 XceedID MIFARE or MIFARE DESFire EV1 card.
 - 10) Configurable to provide compatibility with all standard Prox formats up to 37 bits (including Corporate 1000®).
 - 11) Reader firmware may be upgraded in the field without the need to remove the reader from the wall through the use of factory-provided device.
 - 12) Compliant with the SIA AC-01 Wiegand standard.
 - 13) Reader shall provide the ability to transmit an alarm signal via an integrated optical tamper switch if an attempt is made to remove the reader from the wall.
 - 14) Reader electronics shall be enclosed in a full potted assembly, and provided with a quick connect wire harness.
 - 15) Audio/visual indications shall include:
 - a) An audio beeper shall provide tone sequence to signify: access granted, access denied, power up, and diagnostics.
 - b) A light bar shall provide clear visual status (red/green/amber).
 - 16) Multi-technology contactless reader shall be designed for low current operation to enable migration from most legacy proximity applications without the need to replace existing access control panels and/or power supplies. Contactless smart card power requirements shall be:
 - 17) Operating voltage: 5 – 16 VDC, reverse voltage protected. Current requirements: 160 mA DC, 195 mA PEAK @ 12 VDC
 - 18) Multi-technology contactless reader shall meet the following physical specifications:
 - 19) Color: Black, Gray, Brown or Cream as approved by the project architect.
 - 20) Weatherized design suitable to withstand harsh environments
 - 21) Certified rating of IP65
 - 22) Multi-technology contactless reader cabling requirements shall be:
 - b. Wall Mounting
 - 1) Provide “single-gang” mounting style readers for wall and stanchion mounting, where shown on plans.
 - 2) The reader shall have an approximate read range of up to 3” when used with the proximity access card.
 - 3) Provide HID Signo series card reader, no acceptable.
 - c. Intrusion Card Readers
 - 1) Card readers utilized for arming and disarming of the intrusion system shall be connected to the access control system and provide output to the intrusion alarm panel to provide specified functionality
 - 2) Contractor is responsible for all wiring and equipment necessary between systems to have a complete and operational system.
 - d. Lactation Room Card Readers
 - 1) Provide black HID Multiclass SE RPK40 reader
 2. Provide / coordinate provision of reader licenses for each door with electronic hardware controlled by the system.
- E. Access Control Devices
1. Provide devices as required:
 - a. Controller Power Source
 - 1) Provide: Altronix EFLOW6N single output power supply (provide in Separate Enclosure)
 - 2) Derive primary controller 120VAC power from a designated power source in a secure location, or as shown on plans.
 - 3) Power cable shall be protected by conduit.
 - 4) Transformers shall be installed in locked cabinets, protected by tamper switches. Plug-in transformers which are not protected by locked cabinets are not acceptable.



- 5) Serve all low voltage powered devices from the Electronics Power Supply.
 - 6) Provide barriers as may be necessary to separate Class I from Class II power.
 - b. Electronics Power Supply
 - 1) Provide Altronix AL600ULX-PD8, AL1024ULX, PD4A & Maximal77 UL Listed Class II power supplies as required.
 - 2) Provide Von duprin PS906-2RS w/ 900- BB Power Supplies for QEL devices as required.
 - 3) Capacity: The power supply shall be capable of powering a minimum of 125 percent of the load required at the time of acceptance (25% spare capacity).
 - 4) Power Monitoring: The system shall monitor the loss and restoration of power at the controller of both primary and secondary loss of power. Loss and restoration of power shall be displayed at the console but shall not require resetting of the system.
 - 5) Battery Back-up: Provide battery back-up to retain functions of all electronics for a period of four (4) hours upon loss of 120VAC power.
 - 6) Transformers shall be installed in locked cabinets, protected by tamper switches. Plug-in transformers which are not protected by locked cabinets are not acceptable.
 - c. EACS Alarm Input Board: As required for connection to alarm initiating devices shown connected at this location.
 - d. EACS Output Control Board: As required for connection to controlled devices shown connected at this location.
 - e. Terminations: Provide connections to labeled screw barrier terminal blocks.
- F. Lock Power Supply (LPS)
1. Provide Altronix, UL Listed Class II power supplies within a ventilated, locked, cabinet where indicated on the contract drawings, or as otherwise required to affect proper system performance. Cabinet shall be equipped with a tamper switch, which shall be connected to the EACS to provide a supervisory alarm. Power supply shall include separate terminals for each door lock. Power supply voltage shall be as required by the hardware supplied locks.
 2. Capacity: The power supply shall be capable of powering 200 percent of the load required at the time of acceptance (100% spare capacity).
 3. Power Monitoring: The system shall monitor the loss and restoration of power at the controllers. Restoration of power shall be displayed at the console but shall not require resetting of the system.
 4. Battery Back-Up: Power supplies shall be equipped with integral battery recharging circuits and batteries. If a separate cabinet is used for batteries, the cabinet shall be locked and provided with a tamper switch connected to the EACS.
 - a. Fail Safe Door Locks: Provide 4 hours of battery backup for low-voltage electrified door hardware.
 - b. Fail-Secure Door Locks: Provide battery backup sufficient to operate fail- secure door locks 100 times per hour, for four hours.
 5. Power supply output may be connected to a remote UL-approved distribution board.
 - a. Provide LV-8RS / LV-8A distribution modules as required.
 - b. Distribution modules shall be mounted in a power cabinet.
 - 1) Model LVPC 26x20x07
 6. Provide a Fire Alarm Interface Relay to interface the LPS to the controller and Fire Alarm System, as required by code.
 7. Transformers shall be installed in locked cabinets, protected by tamper switches. Plug-in transformers which are not protected by locked cabinets are not acceptable.
- G. Lock Power Supply (LPS for Latch Retraction Exit Devices)
1. Provide Command Access Technologies, UL Listed power supplies (Model PS-2 or PS-5) within a ventilated, locked, cabinet where indicated on the contract drawings, or as otherwise required to affect proper system performance. Cabinet shall be equipped with a tamper switch, which shall be connected to the EACS to provide a supervisory alarm. Power supply shall include separate terminals for each door lock. Power supply voltage shall be as required by the hardware supplied



locks.

2. Capacity: The power supply shall be capable of powering 200 percent of the load required at the time of acceptance (100% spare capacity). Provide the appropriate number of output channels to support the installed devices, plus expansion channels.
3. Power Monitoring: The system shall monitor the loss and restoration of power at the controller. Restoration of power shall be displayed at the console but shall not require resetting of the system.
4. Solid-state inputs and outputs.
5. Battery Back-Up: Power supplies shall be equipped with integral battery recharging circuits and batteries. If a separate cabinet is used for batteries, the cabinet shall be locked and provided with a tamper switch connected to the EACS. Size the batteries in accordance with the following rules.
 - a. Fail Safe Door Locks: Provide 4 hours of battery backup for low-voltage electrified door hardware.
 - b. Fail-Secure Door Locks: Provide battery backup sufficient to operate fail-secure door locks 100 times per hour, for four hours.
6. Provide a Fire Alarm Interface Link to interface the LPS to the controller and Fire Alarm System, as required by code.
7. Used with Command Access PM300 latch retraction device modules, and other compatible lock types.

H. Alarm Initiating Devices

1. Door Position Switch: Door Position Switches shall be furnished and installed by the Contractor. The Contractor shall align, prepare and fabricate doors and frames to accept specified door position switches. The Contractor shall be responsible for coordinating the installation, so systems and hardware operate as specified.
 - a. Surface Mounted Door Switch:
 - 1) Nascom N1178C series or approved equal Surface Mounted Magnetic Switch with armored cable. Route armored cable to junction box and permanently secure to box with clamp or set-screws. Use only where flush mounted devices cannot be installed.
 - b. Flush Mount:
 - 1) Nascom N1178CW/STDD (DPDT) Concealed Magnetic Door Switch.
 - c. Gates and Roll-Up Doors:
 - 1) Nascom N1178CW/STHS Floor Mount Contact Extra Heavy Duty, with armored cable. Route armored cable to junction box and permanently secure to box with clamp or set-screws.

I. Exit Request Detector:

1. Coordinate with the door hardware vendor and use the provided Exit Request Touch Bar or integral lock signal switch, as specified in Division 08.

J. Lock Down Button:

1. Lock down button shall be furnished and installed by the Contractor. Upon first valid card read into room, door will remain unlocked via EACS programming. The momentary Lockdown button shall be connected as input to EACS system and upon activation, trigger relocking of door(s) of room containing Lockdown button only. Valid card read will reopen door. The Contractor shall be responsible for coordinating the installation, so systems and hardware operate as specified.
 - a. Provide STI SS2324LD-EN white, momentary pushbutton with shield.

K. EACS Lenel Product Licenses

1. Provide PRO64RUP reader license bundle
2. Provide 1-year Lenel Software Support License SUSP-PRO-TR-3

2.3 INTRUSION SYSTEM

- A. Purpose: The intrusion panel will be used as a communicator to local authorities for EACS events defined herein.



- B. Environment:
 - 1. The system shall be wholly contained within the MiraCosta Health and Wellness Hub. Refer to the drawings to determine the scope limitations for this work.
 - 2. Security Alarm Monitoring: Security alarm signals shall be transmitted to the local authorities via WAN or telephone lines provided by the Owner. Trouble signals shall be sent to the EACS system and displayed as events.
- C. Attributes
 - 1. System Control Panel
 - 2. System Software: The base panel shall come complete with the software necessary to implement every system feature and to allow for the addition of every expansion or functional module without changes or addition to the basic software.
 - 3. The system shall be U.L. listed for Central Station, Local and Auxiliary, and Burglary (UL Central Station and Local) applications.
 - 4. Voice-Assisted Status & Control: The system shall be capable of providing system status and control via any local or remote tone telephone, with the system providing system status information by voice. The system shall include a pre-recorded word library from which words can be selected to create zone labels.
 - 5. System shall bear the following listings as necessary to meet the requirements of governing authorities:
 - 1) UL1610 Central Station Burglar Alarm Units
 - 2) UL609 Local Burglar Alarm Units
 - 3) UL365 Police Station Burglar Alarm Units
 - 4) UL1635 Digital Alarm Communicator System Units
 - b. Parts:
 - 1) Provide: B9512G panel
 - a) Provide: UL Listed battery backup within the system control panel to retain all functions of the electronics for a period of (12) hours upon loss of 120VAC power.
 - b) Provide: tamper switch
 - 2) Provide: D8125 Popex Zone Expanders, D9127U POPITs and other necessary input/output boards as required to per the specification and drawing requirements.
 - 3) Provide: Bosch Keypad D1260 mounted in environmental enclosure as shown on the drawings.
 - a) Provide: STI-7511B outdoor enclosure
 - 4) Provide: (2) Bosch B426 Ethernet Communication Modules
 - 5) Provide: Bosch DS9370 Ceiling Mounted Motion Detectors
 - 6) Provide: (3) Bosch RPS Dongles

2.4 WIRE AND CABLE

- A. General: Cables which are not installed in conduit shall be a version of the specified cable rated for use in plenums.
- B. System cable: Provide cable as shown below, or as recommended by the Manufacturer.
 - 1. Composite Cable (Reader, Lock, Monitor, REX): Belden P/N 658AFS jacketed Plenum cable with overall shield, including 6-Conductor Shielded 22AWG w/ripcord, 4-conductor 22AWG w/ripcord, 2-Conductor 22AWG w/ripcord, and 4- conductor 18 AWG w/ripcord; or equal with approval by Owner
 - 2. Card Reader Cable for single Intrusion arming card reader: Windy City Wire P/N 004351, 3 Pair Shielded 22AWG or approved equal.
 - 3. Intrusion door contact: Belden P/N 6502FE Jacketed Plenum cable, shielded 4 conductor 22 AWG or approved equal.
 - 4. Area Motion Detector: Belden P/N 6502FE Jacketed Plenum cable, shielded 4 conductor 22 AWG or approved equal.



5. Network Cable: As specified in 27 10 00.

C. Cable installed below grade shall be rated for immersion in water.

PART 3 - EXECUTION

3.1 GENERAL

A. In accordance with Section 28 05 00, Access Control General Requirements.

3.2 SPECIAL INSTRUCTIONS

A. Door Hardware Coordination

1. Doors shall not be locked in path of legal egress.
2. Refer to Section 08 71 00 for door hardware requirements and coordination. Contractor shall work directly with door hardware supplier to ensure the provision of specified mechanical functionality.
3. Refer to Section 08 71 00 for electrified door hardware requirements and coordination. Security Contractor shall provide, install and terminate all electrified door hardware in conjunction with mechanical hardware by others.
4. Owner approved electronic lock hardware (no substitutes permitted):
 - a. L9092EU06LRXBD is approved standard mortise lock.
 - 1) SFM IC CORE required per exit device, confirm exact type and model with owner prior to order
 - b. PA-QELRXSD98NLX990NLUS26D is approved electrified crash bar/exit hardware.
 - 1) 80-129 CYLINDER AND SFM IC CORE required per exit device, confirm exact type and model with owner prior to order
 - 2) The pad armor or "PA" designation shall prevent the catching of articles of clothing or other items on the panic device. The inclusion of this designation is a State of California Requirement.
 - c. All lock hardware is to include integral request to exit (REX) switch.
 - d. If there are any discrepancies between Section 08 71 00 and hardware specified herein, consult security design consultant for clarification.
5. Security contractor to provide and install required lock power supplies for all electrified door hardware. Coordinate AC power requirements with electrical contractor.
6. Request-To-Exit Activation: Contractor shall configure system such that Request- To-Exit devices and System Controllers will react quickly enough to bypass alarms before a fast- moving individual can reach and open the door. This bypass process shall be evaluated and verified by the Contractor on the fully configured and operational EACS system, prior to acceptance testing.
7. Fire Alarm Interface: Electrified locks and strikes which are part of this work and which may be locked in the path of legal exiting, shall be connected to the building Fire Alarm System in accordance with AHJ requirements such that they automatically unlock in the event of activation of the Fire Alarm System. This shall occur whether the activation is a result of a manual pull station, smoke detector or sprinkler flow switch.
 - a. A fire alarm "general/common alarm relay" shall be programmed at the fire alarm control panel to activate the EACS interface relays located in each Lock Power Supply cabinet. The Access Control Contractor shall research and provide all necessary fire alarm system conduit, wire, hardware, and programming to perform the required interface.
 - b. This interface shall not depend on the EACS Host or Remote Controllers for its operation. Locate these interface relays electrically ahead of lock power distribution as shown on the drawings. The Contractor shall supply and install programmed alarm interface relay(s) with sufficient capacity to control the power supplied to all controlled locks.

B. Access Control and Lock Configuration

1. Secured Doors: Doors equipped with electric locks shall be individually programmed for locking and unlocking at specific times of the day. A valid credential presented at a reader will allow the portal to unlock for a programmed period of time.



2. Stairwell Door Locks
 - a. Stairwell doors which are locked from the stairwell side shall have the capability to be simultaneously unlocked upon a signal from the Fire Command Center, Fire Alarm Panel, or the Access Control Command Center.
 - b. Stairwell locking systems shall, in all respects, comply with the requirements of the California Building Code, "Means of Egress".
 - c. Contractor shall provide clearly labeled switches, in the required locations, to unlock all stairwell doors simultaneously. Coordinate wall or desk mounted switch style, with the Owner and the Authority Having Jurisdiction.
 - d. This interface shall not depend on the EACS Host or Remote Controllers for its operation. Locate interface relays for each stairwell door electrically ahead of EACS lock control, to independently override EACS control.
 3. Upon authorization by card reader or manual means, "door force" and "door held open" alarms associated with the portal shall be automatically bypassed (prevented from reporting an alarm) for a duration of time that is programmable on an individual door and individual cardholder basis.
 4. The door shall re-lock immediately upon closing, after an authorized access, and the bypass duration shall be immediately truncated. A door position switch will be required at every door for this purpose. The same door position switch shall be used to sense the position of the door for "door forced" and "door held open" alarms.
 5. Free Egress Authorization
 - a. Unless otherwise shown on the plans or described herein, the system shall detect the normal egress of a user at any individual portal and shall bypass any alarm associated with the portal for a duration of time that is programmable on an individual door and individual cardholder basis.
 - b. Timing shall be independently programmed for each portal during the initial enrollment process. This function allows extended timing for disabled persons to pass through a portal.
 - c. The timing function shall automatically truncate after an adjustable period (0-4 seconds) after a portal is closed. This feature allows a subsequent alarm at the portal to be detected and prevents the portal from being re-opened without an authorized request.
 - d. "Request-to-Exit" devices shall be used to signal the system that an individual is ready to exit the secured door. Request-to-Exit devices may include but not be limited to
 - 1) Integral Lock Handle Signal Switches
 - e. On doors with integral electro-mechanical locking mechanisms (strikes, electrical panic hardware, or electrical mortise locks), the mechanical action of the door hardware shall enable egress without requiring release of the electrical mechanism. The Request-to-Exit device shall not unlock the door.
- C. Sequences: Verify each door type sequence at each door with the Owner.
1. Doors with Door Position Switch (DPS) and Request-to-Exit (REX) devices
 - a. DPS and REX contacts shall be wired to EACS auxiliary input. Configure the EACS to mask the associated DPS alarm for a minimum of 45 seconds. Coordinate the required masking duration with the Owner.
 - b. EACS shall report a "door forced" alarm when any time the door is opened without a valid REX request. The subsequent operation of an associated REX shall not abort a "door forced" alarm already sensed by the system.
 - c. EACS shall report a "door-held-open" alarm after the door has been opened and the masking duration has ended.
 2. Doors with Electronic Locking (EL), DPS and REX devices
 - a. DPS and REX contacts shall be wired to EACS auxiliary input. Configure the EACS to mask the associated DPS alarm for a minimum of 45 seconds. Coordinate the required masking duration with the Owner
 - b. Electronic lock shall be wired to EACS auxiliary output. Configure the EACS to mask the associated DPS alarm during timed or commanded unlock



- c. Electric lock shall be locked and unlocked based on preprogrammed schedules and conditions, and by manual control from the EACS client workstations.
 - d. EACS shall not cause an alarm event when door is unlocked
 - e. EACS shall report a "door forced" alarm when any time the door is opened without a valid REX request. The subsequent operation of an associated REX shall not abort a "door forced" alarm already sensed by the system.
 - f. EACS shall report a "door-held-open" alarm after the door has been opened and the masking duration has ended during locked mod
 - g. REX device shall not unlock the door
3. Doors with Card Access Control (CR) and/or Biometric Reader(s), EL, DPS and REX devices
- a. CR or Biometric Reader(s), EL, DPS and REX devices shall be wired to a door controller board
 - b. Electronic lock shall be locked on command from the system at any time
 - c. Electronic lock shall unlock during a preset time zone or from the system
 - d. Electronic lock shall be unlocked and shall not require use of a reader during timed unlock mode
 - e. EACS shall not report activity when door is unlocked
 - f. During locked mode Card Reader and/or Biometric Reader shall unlock the door, mask DPS preventing alarm
 - g. EACS shall report a "door-held-open" alarm after the door has been opened and the masking duration has ended
 - h. EACS shall report a "door forced" alarm when any time the door is opened without a valid REX request. The subsequent operation of an associated REX shall not abort a "door forced" alarm already sensed by the system.
 - i. REX device shall not unlock door
4. Doors with Auto-Operators, Proximity CR, and/or Biometric Reader(s), EL, DPS and REX devices
- a. Auto-Operator controls CR, Biometric Reader(s), EL, DPS and REX devices shall be wired to a door controller board
 - b. Electronic lock shall be locked on command from the system at any time
 - c. Electronic lock shall unlock during a preset time zone
 - d. EACS shall not report alarm activity when door is unlocked
 - e. Day mode; proximity card reader and/or Biometric reader shall activate the auto operator to open the door
 - f. Secure mode:
 - 1) Reader, auto operator function, shall activate the auto door operator at all times.
 - 2) Reader shall unlock the door, mask the DPS device preventing alarm and allow use of door open pushbuttons. Electronic lock to be unlocked prior to door open mechanism is engaged. Where auto door equipment is not provided with door open pushbuttons, the door shall automatically open after unlocking
 - g. EACS shall report a "door-held-open" alarm after the door has been opened and the masking duration has ended during locked mode
 - h. EACS shall report a "door forced" alarm when any time the door is opened without a valid REX request. The subsequent operation of an associated REX shall not abort a "door forced" alarm already sensed by the system.
 - i. Use of push plate shall activate the EACS REX, unlock the door and operate the auto door system.
 - j. Door shall report a door held open time when REX (push plate or signal from the door operator) is activated, door is opened from the secured side and the system bypass time has expired during locked mode.
 - k. Verify interior push plate is operational in both locked and unlocked modes
 - l. Verify exterior push plate is operational during unlocked mode
 - m. Verify exterior push plate is non-operational until valid card read during locked mode



- n. Verify exterior push plate is operational after valid card read during locked mode
 - o. Verify door can be manually opened during locked mode from secured side
- D. Electrical Connections to Door Hardware: Wire connections to door hardware pigtail leads shall be made using the manufacturer-provided quick-connect devices, or by Dolphin insulated displacement connectors. Wire nuts and splices are not acceptable.
- E. Tamper Devices
- 1. Terminal cabinets, equipment cabinets, enclosures, power supply cabinets, exposed wireways, and pull and junction boxes with wire connections or splices located in public or multiuse locations shall be equipped with tamper switches programmed to report an alarm. Equipment contained within a security managed zone such as an IDF room do not require tamper alarms/switches.
 - 2. Junction boxes requiring tamper switches that are associated with an individual alarmed device (such as a door position switch) may report to the respective device alarm point, if end-of-line resistors and the system are configured to support 6-state alarm reporting. Other cabinet and box tamper switches shall report as independent alarm points.
 - 3. Power Supply/Battery Chargers: Power supply/battery chargers shall be connected to alarm monitoring points to provide an "Event" indication of tamper, power failures and other system troubles.
- F. Intrusion alarms
- 1. The Intrusion panel shall be configured to communicate to local authorities via Owner's WAN. Coordinate connection with Owner.
 - 2. This building has an existing Sonitrol intrusion system that must be completely removed, including all existing cabling, devices, power supplies and keypads.
- G. EACS Connectivity
- 1. Access Control Network: EACS Servers, Client Workstations and Controllers shall reside on the Owners' Local Area (LAN) and/or Wide Area Network (WAN) to allow global event activity and shared data interchange.
 - 2. Provide and coordinate with Owner IT adequate network "firewalls" to maintain the security of EACS controls and information while connected to shared computer networks and transmission media. Contractor shall coordinate shared resource usage with the Owner, and develop network security schemes acceptable to the Owner to ensure the integrity of the EACS.
 - 3. LAN Communications & Connectivity, (Integrated CPU's and Controller's):
 - a. Provide LAN communications interfaces for the applicable EACS Server, Clients, and Controllers to support multiple workstation and integration schemes that are part of this work.
 - b. LAN Communications: Contractor shall utilize the facility's Local Area Network for EACS connections and interfaces, as shown on the drawings and described herein.
 - c. Coordinate with EACS equipment and software manufacturers to provide network interface devices compatible with the established LAN/WAN network.
 - d. Coordinate with the MiraCosta Information Systems Department to provide EACS clients, network interface devices, bandwidth utilization, and appurtenances acceptable to the Owner.
 - 4. Controller Communications
 - a. Inter-Facility: Between facilities, buildings, and controller "groups", the controller network shall be implemented utilizing the access control Owners infrastructure and connectivity, as shown on the drawings and described herein.
 - b. Between controllers at an individual location, and between controllers located within the same building, the controller network may be implemented using standard, twisted, shielded copper conductors as approved by the system manufacturer. It is also acceptable for controllers to be LAN connected, regardless of location.
- H. Emergency Standby Power
- 1. Servers, Computers, Clients, and Other 120VAC Equipment: Provide a UPS with sufficient time for power transfer where the respective buildings have an Emergency Power (EP) source. Where a



building EP source is not available, provide sufficient UPS time to allow the system to run for a minimum of 1-Hour, plus (15) minutes to manage the shutdown process.

2. Low-Voltage Equipment: EACS Remote Controllers, peripheral devices and Lock Power Supplies shall also have their own 4-hour battery back-up systems.
 - a. Power back-up may be in the form of direct DC battery power back-up or by 120VAC Uninterruptable Power Supplies (UPS), depending upon equipment requirements.
 - b. Lock Power Supplies shall allow fail-secure locks to be operated by the system a minimum of 100 times-per-hour, during this time period. Fail-safe locks shall be maintained for the full 4-hours.
 - c. Battery back-up systems may be distributed throughout the facility to provide the required emergency power to individual components.
 - d. Battery back-up systems shall include battery chargers to keep storage batteries at their peak charge.

3.3 ACCESS CONTROL SYSTEM INTEGRATION

- A. Provide access control system integration equipment, software and programming, in accordance with Section 28 07 00, Access Control System Integration. In addition, provide specific integration schemes noted.
- B. Intrusion Panel Integration
 1. Intrusion panel shall integrate with EACS to arm the system via valid card read on separate, dedicated arming card reader. This is accomplished through hard-wired integration.

3.4 EQUIPMENT, RACK, AND CONSOLE INSTALLATION

- A. Mount equipment in rooms, consoles, equipment racks, and desktops in accordance with Section 28 05 00, Security System General Requirements.

3.5 GROUNDING PROCEDURES

- A. Provide grounding of all systems and equipment in accordance with Section 28 05 00, Security System General Requirements.

3.6 WIRE AND CABLE INSTALLATION PRACTICES

- A. Provide wire and cable installation in accordance with Section 28 05 00, Security System General Requirements.

3.7 DATABASE PREPARATION, CHECKING AND ACTIVATION

- A. Provide database preparation, checking and activation for systems and equipment in accordance with Security System General Requirements, Section 28 05 00.
- B. Provide the following special programming services:
 1. Contractor shall research with the Owner, develop, and install executive and user software required for the final acceptance of the system as specified herein and on the drawings.
 2. Contractor shall provide the Owner with forms and instructions to facilitate the gathering and entry of user software data. Forms shall include but not be limited to information regarding cardholder data, access privileges, time schedules, portal groups, access groups, alarm points, tenant/elevator authorization, password protection levels, two-man and anti-passback locations
 3. Default Access control time zones for each building shall be set as follows:
 - a. Normal Business 6 AM to 6PM allowing free access through any portal without creating an alarm event
 - b. Card Access Only from 6PM to Midnight by card holders with valid cards.
 - c. Restricted Access from Midnight to 6AM for authorized card holders only as programmed by the Owner.



3.8 START-UP RESPONSIBILITY

- A. Provide start-up services for all systems and equipment in accordance with Security System General Requirements, Section 28 05 00.

3.9 PRELIMINARY INSPECTION AND TESTING

- A. Provide preliminary inspection and testing services for systems and equipment in accordance with Testing and Commissioning, Section 28 08 00.

3.10 SYSTEM PERFORMANCE TESTING AND ADJUSTING PROCEDURES

- A. Provide performance testing and adjusting of systems and equipment in accordance with Testing and Commissioning, Section 28 08 00.
- B. Electronic Access Control System Testing
 1. Test and verify the normal operation of every alarm point in all four states at each alarm panel. Test each alarm point for the alarm function by normal operation of the alarm point.
 2. Test and verify the normal operation of the Access Control System for each sequence
 - a. Minimum testing shall include but not limited to:
 - 1) Testing of Lockdown Button
 - 2) Auto disarm by way of door reader
 - 3) Valid Card or Biometric Read (No Alarm)
 - 4) Electronic lock relock time (Door not opened)
 - 5) Door held open alarm time (Alarm)
 - 6) Forced door open (Alarm)
 - 7) Electronic lock relock on close (Closed within relock time)
 - 8) REX bypass Alarm on exit
 - 9) REX does not unlock door
 - 10) Valid card read during active REX
 - 11) Associated Camera integration call up during alarm event
 - b. Testing shall be recorded on approved forms.
 3. Test each door during its programmed secure time period to assure that the system commands the lock to activate, and permits access by valid access card holders within one second from presentation of the access card.
 4. Verify egress systems on access-controlled doors work correctly.
 5. Verify system integration schemes function automatically and correctly.
 6. Verify activity at Client Monitoring Station functions correctly
 7. Verify operation of auto-door operation.

3.11 BURN-IN PERFORMANCE PERIOD

- A. Provide a burn-in performance period to demonstrate the stability of the system, in accordance with Testing and Commissioning, Section 28 08 00.

3.12 COMMISSIONING AND VALIDATION

- A. Provide commissioning and validation services to prove and improve the effectiveness of the system, in accordance with Testing and Commissioning, Section 28 08 00.

3.13 TRAINING

- A. Provide training requirements of Security System General Requirements Section 28 05 00
- B. Contractor shall provide a minimum of two (2) reprogramming training sessions within twelve (12) months of the final acceptance of the system to modify the user programming.
- C. User group training shall include:
 1. Building walk-through indicating locations of equipment and their usage
 2. User operation of client workstations, including alarm monitoring, manual door override, card reader reports, and along with user group special operational request.



- D. Maintenance group training shall include:
 - 1. Building walk through indicating locations of equipment and their usage
 - 2. Location and usage of project specific forms located in the equipment showing relationship between devices and connectivity to the Owners network
 - 3. Trouble shooting procedures
 - 4. Operational usage of the equipment
 - 5. Procedures for obtaining technical service and repair of equipment.

3.14 FINAL PROCEDURES

- A. Perform final procedures in accordance with section 28 05 00, Security General Requirements.

END OF SECTION 28 13 00



SECTION 28 23 00
SECURITY CAMERA SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Contractor shall provide all materials, hardware, software, fabrication, coordination and installation, programming, testing, documentation, and training in conformity with manufacturers' documentation, the specifications contained herein, all applicable Codes and authorities having jurisdiction for the implementation of a complete Video Security System (VSS). Refer to Scope of Work section within this specification for further details.
- B. Contractor shall be responsible for coordination of all VSS system related installation issues with any and all stakeholders, MiraCosta Community College District (MCCD) IT Department, MCCD Security Department and other trades. This includes programming of all software and hardware, connections/interfaces. Coordination of conduit/pathways, and power requirements for security devices directly with electrical contractor when necessary to complete installation. Refer to Scope of Work section within this specification for further details.

1.2 SCOPE OF WORK

- A. Contractor shall be responsible for fully implementing the functions described in this Specification and shown on the Design Drawings, which may not show or list every item required for a complete turn-key VSS. When an item not shown or listed is clearly necessary for proper installation and operation of equipment or the system(s), Contractor shall provide this equipment, component, or software at no additional cost to MCCD. Delivery of the work described in this Specification shall include, but not be limited to, the following Services:
 - 1. Engineering and Design: Contractor shall provide all system engineering and design necessary to develop the complete systems described herein. Engineering and Design shall include preparation of all necessary electronic schematics, hardware drawings, systems diagrams, schedules, and lists. Additionally, final system design and configuration with the MCCD, as well as on-site Security coordination and infrastructure installation review with the Construction Contractor is required.
 - 2. Assembly: Contractor shall procure and assemble all hardware and equipment (Contractor Furnished, Contractor Installed), and any additional materials as required to deliver a complete functional VSS.
 - 3. Software Programming: Contractor shall perform all required software setup, configuration, and programming required to develop a complete operating system in accordance with this Specification, including all control logic and interface programming.
 - 4. Installation: Contractor shall install all equipment, cable, conduit (where required), wiring, connectors, plates, and other material at the Project site per the Architectural Design Team and/or Integrator's MCCD approved design documents. Contractor shall install any MCCD furnished equipment identified in this document and calibrate it to work with the integrated systems.
 - 5. Testing and Adjustment: Contractor shall perform all tests and adjustments, furnish all test equipment necessary and perform all work required to properly configure the systems and to verify their performance in accordance with the information in this Specification and Architectural Design Team and/or Integrator's MCCD approved engineered designs. Completed Testing checklists will be provided to the MCCD or MCCD Representative for review and approval.
 - 6. Acceptance Testing: Prior to MCCD acceptance and hand-over of the completed VSS, Contractor shall demonstrate the operation of the complete systems, including all individual devices and specified control functions. Both subjective and objective tests may be required by MCCD to determine compliance with the information in this Specification and the Integrator's MCCD approved designs. Prior to MCCD or MCCD Representative

performing their system acceptance, completed Integrator testing reports will be provided showing all systems are in complete operation.

7. Training: Contractor shall provide technical training for MCCD's staff, instructing them on VSS operation, maintenance, and troubleshooting. Contractor shall provide option for MCCD staff to attend Manufacturer training when requested or in case MCCD staff can receive certification for maintenance of installed equipment.
8. Warranty: Contractor shall warranty the VSS in accordance with the terms of this Specification.
9. Contractor shall coordinate all work in harmony with other trades on the project as well as A/E personnel and contractors performing work under a separate contract where all work is contributing to the overall project. Cooperate fully with the Architect or his agents so work may be carried out smoothly, without interfering with or delaying work under this contract or work by Architect. This would include timely submission of documents and/or notices of impending scheduled events or milestones where others are required to attend or participate in reviews, site walks, testing, commissioning, and demonstration for Final Acceptance with the A/E personnel.

1.3 DEFINITION OF TERMS

- A. Definitions of the terminology used in this Specification are as follows:
 1. Owner or Client: shall refer to the MiraCosta Community College District (MCCD), or their designated representative.
 2. Architect: shall refer to individual project architect.
 3. General Contractor: (GC) General Contractor.
 4. Bidder: shall refer to any party proposing to provide the services and material delineated in this Specification
 5. Bid: shall refer to a Bidder's proposal to provide the services and material delineated in this Specification
 6. ESS: Electronic Safety and Security
 7. Security Consultant (Consultant): shall refer project consultant.
 8. Contractor: shall refer to the Contractor contracted to provide the services and material delineated herein
 9. Specification: shall refer to the complete set of designs, performance and delivery requirements delineated within this document and all referenced documents
 10. Video Security System (VSS): shall refer to the complete compliment of equipment, software and other material that upon completion of assembly, installation and configuration provides the full functionality and technical performance delineated in this Specification.
 11. Security Equipment (Equipment): shall refer to any and all individual equipment items and OFCI equipment items installed as a part of the Security System
 12. Work: Design and provision the VSS and associated equipment, software, and services for the Project
 13. Construction Documents: shall include all documentation associated with the design and general construction of the Project, including this Specification.
 14. Provide: Supply, deliver, install, test, configure, label, and commission.
 15. Manufacturer: shall refer to the original manufacturer of any equipment provided as part of the Work
 16. Commissioning Date: shall refer to the date at which a system is formally accepted by the MCCD.
 17. OFCI: Owner Furnished, Contractor installed.
 18. CFCl: Contractor Furnished, Contractor installed.
 19. OFOI: Owner Furnished, Owner installed.
 20. OFE: Owner Furnished Equipment.

- B. This Scope of Work Specification establishes and details the requirements to provide and install automated security equipment, various systems, devices, and software for monitoring and controlling for the MCCD projects located within the district purview in San Diego County, CA. Section includes:
 - 1. Video Security System
 - 2. Emergency Phones / Call Boxes
- C. Related Work:
 - 1. The requirements of General Conditions, Supplementary Conditions, and Division 1 – General Requirements apply to this Section.
 - 2. Section for Door hardware, hardware power supplies, and door contact switches.
 - 3. Section for Raceway, and junction box systems (except specialty back boxes).
 - 4. Section for Fire alarm system connection for ancillary monitoring.
 - 5. Section 271000 – Structured Cabling Systems.
 - 6. Section 281300 – Electronic Access Control and Intrusion Detection Systems
- D. Confidentiality: Drawings and specifications involving the Integrated Electronic Safety and Security (ESS) system represent a vulnerability to the security of the facility and are to be considered confidential information.

1.4 REFERENCES

- A. The Contractor shall install the system in accordance with the latest edition of the following industry standards:
 - 1. NEC – 2020 National Electrical Code, NFPA 70
 - 2. Commercial Building Telecommunications Wiring Standard, ANSI/EIA/TIA 568
 - 3. Commercial Building Standard for Telecommunications Pathways and Spaces, ANSI/EIA/TIA 569.
 - 4. National Electrical Manufacturer's Association (NEMA).
 - 5. NFPA 3000 (PS) – 2018 Standard for Active Shooter/ Hostile Event Response (ASHER) Program
 - 6. ADA – Title 3 of the Americans with Disabilities Act
 - 7. ASCII – American Standard Code for Information Interchange
 - 8. ASTM – American Society for Testing and Materials
 - 9. CCR – Titles 19 and 24 of the California Code of Regulations
 - 10. CEC – 2017 National Electrical Code with 2019 CA Amendments
 - 11. CBC – 2018 International Building Code with 2019 CA Amendments
 - 12. CFC – 2018 International Fire Code with 2019 CA Amendments
 - 13. CMC – 2018 Uniform Mechanical Code with 2019 CA Amendments
 - 14. UL – Underwriters Laboratories, Inc.
- B. Where any of the above standards or codes differs with the contract documents and Specification, the more stringent requirements shall take precedence. Any cost necessary to meet any AHJ requirements shall be included in the Contractor's price.

1.5 SYSTEM DESCRIPTION

- A. VSS will be accessible remotely at the MCCD Campus Safety Office. Mobile monitoring and control shall be provided as a function of the system. Web and app-based monitoring shall be enabled and supported as part of the server hardware and software.
- B. Provide new cameras, housings, mounts, power supplies, connections to computer hardware and software, and connect them to the existing Verkada Command Platform. Integrate new Security Camera System components. Support the new components with miscellaneous hardware and cabling.
- C. MCCD IT shall provide all network switches. Contractor shall coordinate with MCCD Network Engineering for coordination of VSS utilizing the owner-furnished data network.



- D. As part of this work, Contractor shall provide programming, facility graphic mapping, and field device assignments for the cameras under this scope of work. To accomplish this, Contractor shall coordinate camera locations, camera types, and termination points on the VSS and MCCD Network with MCCD personnel, as directed by the MCCD's representative.

1.6 QUALITY ASSURANCE & QUALIFICATIONS

- A. Manufacturer's qualifications: The equipment manufacturer shall provide accreditation that the Contractor or the Contractor's agents have been certified to install, warrant, and support the major components of the system. Submit accreditation with bid.
- B. Contractor shall be a factory authorized representative of the VSS, licensed to sell, install, and maintain all system, subsystems, components, and software required in the United States, and shall present a copy of their certificate designating them as a factory authorized distributor/installer.
- C. Contractor shall certify that the installations of all materials and equipment, and programming of all project-purchased software, provided and/or performed in conjunction with this project is in compliance with each manufacturer's installation and operation specifications.
- D. Contractor / subcontractor performing the scope of work pursuant to the Business and Professions Code and shall be licensed in the following classification: C-28.
- E. Contractor shall have at least five (5) years' experience designing, selling, installing, and maintaining the VSS equipment being bid, and shall possess all applicable Contractor licenses.
- F. Skilled technicians are to perform all installation, commissioning, programming, and testing and are, at a minimum, to be factory trained and certified to work with the video Security system.
- G. Contractor shall employ a competent Foreman to be in responsible charge of the Work. Foreman shall be on the project site daily during the execution of the Work.
- H. Contractor's Foreman shall be a regular employee, principle, or officer of Contractor, who is thoroughly experienced in projects of a similar size and type. Contractor shall not use contract employees or Subcontractors as Foremen.

1.7 SUBMITTALS

- A. General Submittal Requirements
 1. A submittal package consists of all items (forms, lists, drawings, etc.) specified for that submittal.
 - 2.
 3. Submittals must be complete, as all items listed under Shop Drawings and Data Sheets shall be submitted at one time together as a package. Incomplete or partial Shop Drawings and Data Sheets submittals shall be rejected.
 4. Unless directed otherwise in writing by MCCD and/or MCCD Representative, the Contractor is not authorized to proceed with the acquisition, assembly or installation of any systems or components until all required submittals have been approved by MCCD and/or MCCD Representative. Any acquisition, assembly or installation of any systems or components without either MCCD and/or MCCD Representative's approval are installed at the Contractor's risk and will be subject to removal at the Contractor's expense.
 5. Contractor shall coordinate with MCCD and/or MCCD Representative prior to the delivery of each submittal to obtain the proper equipment quantities of submittals to each recipient.
 6. Unless otherwise instructed, Contractor shall provide five copies of all submittals.
 7. Product cut sheets shall be submitted electronically on one compact disc with a separate "table of contents" listing all the cut sheets included.
 8. Product cut sheets shall accompany all requests for product substitutions.
 9. MCCD and/or MCCD Representative shall notify Contractor if any sample products are required for fit or finish coordination. Samples shall be provided by Contractor upon request and at no additional cost to the MCCD.

10. Drawing Formatting Requirements:

- a. Shop Drawings shall be numbered consecutively and shall accurately and distinctly present the following information:
 - a) Title Sheet
 - b) Single-Line/Block Diagrams showing signal relationships of all controls and devices within the system.
 - c) Necessary details, including complete information for making connections between work under this Contract and work under other Contracts.
- b. Formatting of shop drawings and other drawing submittals shall include the following:
 - a) Title Block with;
 - b) Project name and address, Project Number and Drawing Name.
 - c) Sequential number of submittals
 - d) Date of submittal
 - e) Name and address of Contractor
 - f) Drawing Scale
 - g) Critical dimensions at accurate scale
 - h) Submittal date and space for revision dates.
 - i) Identification of equipment, product or material.
 - j) Name of Supplier / Manufacturer.
 - k) Physical dimensions, clearly identified, where applicable.
 - l) Specification references.
 - m) Identification of deviations from the Contract Documents, if necessary.
 - n) Contractor's stamp, initialed or signed, dated and certifying to review of submittal, certification of field measurements and compliance with Contract.
- a. Contractor's drawings shall clearly identify the specific equipment make and model number(s) as well as specific System configuration and installation requirements as noted below.
 - o) Type fonts must be legible (minimum 1/16" on 11x17 prints) and must be exportable to .DWG or .DXF format.
 - p) Plans indicating Equipment layouts shall be scaled to be not less than 1/8" = 1'-0". Details for particular equipment mounting shall be scaled to be not less than 1/4" = 1'-0".
 - q) Background CAD files (in .DWG format) of the building will be made available to the Integrator if requested.
 - r) MCCD and/or MCCD Representative assumes no responsibility for errors and/or omissions due to electronic translation of CAD file formats.
 - s) Prior to being issued electronic Project documents, Contractor shall warrant in writing that any electronic files given to Contractor for use on the Project will be used only for the Project, and that any intellectual property originated, copyrighted and/or owned by others is for use only on this Project.
 - t) Any building plans or drawings originated by others and reproduced by Contractor in their documentation shall be labeled with "Contractor Shop Drawing" and the names and stamps of others shall be removed.

11. Use architectural technology infrastructure constructions plans and specifications for reference (obtainable through Construction Manager or Architect).

12. Weekly Status Reports

- a. Contractor shall provide weekly progress updates to the Architect and MCCD and/or MCCD Representative. Weekly Status Reports shall be submitted as directed by the CM via hard copy or electronic means (i.e. email). Issuance of Weekly Status Reports shall commence from the date of the first submittal delivery and shall continue until contract closeout.



- b. The Weekly Status Report shall not be used as an official means of communicating Project issues. It does not replace any part of a required submittal, request for information, proposed change order, report of field conditions, schedule issues, etc. No official response will be given to the Weekly Status Report.
- c. A representative of the Contractor shall attend the weekly construction meeting at the job site. This representative shall be fully knowledgeable in all aspects of the Project and the Contractor's work and shall have the authority to make binding commitments on behalf of the Contractor.

B. Project Commencement Submittals

- 1. Immediately upon award of contract and authorization to proceed with the Work, Contractor shall commence initial planning and coordination. Project Commencement Submittals required upon commencement of the Work shall include, but not be limited to, the following:
 - a. Project Plan
 - a) Provide a complete and detailed Schedule for the Contractor's work describing the major tasks, sequence of work, submittals, and other critical milestones. At a minimum the tasks noted in the Schedule shall include all required submittals, rack assembly and shop testing, on-site cable installation, periodic shop, and site visits, on-site equipment installation, testing and commissioning, Substantial Completion and Project Completion. Indicate the sequence of installation and completion by room and/or system. The Schedule shall also include anticipated dates of acquisition of major equipment and their installation milestones.
 - b) Provide a complete listing of the Contractor's project team, including the names and all contact information (email address, cell phone, etc.) for all personnel assigned to the Project. At a minimum this Project Team Directory shall include the Contractor's executive in charge of the Project as well as the Project Manager, Lead Engineer, and Lead Installer. Include names and contact information for all subcontractors.
 - b. Listing of Long Lead Time Equipment
 - a) Contractor shall submit a list of long-lead items including OFCI items. These are items that may be necessary to order ahead of the submittal and approval sequence to avoid adversely impacting the project schedule. Do not include equipment that will be ordered within the scheduled submittal and approval process.
 - c. Contractor shall use reasonable judgment in determining which products are legitimate long-lead items. Failure to include an item that may require long procurement lead time shall not relieve the Contractor of responsibility for furnishing the item to meet the agreed Schedule.

C. Engineering Submittals

- 1. Contractor shall present documentation delineating the complete requirements for Security System engineering, fabrication, assembly, installation, commissioning, and testing. Engineering Submittals shall be presented to the Consultant for review, comment, and approval prior to commencing further work. Engineering Submittals shall include, but not limited to, the following:
 - a. Equipment List
 - a) Provide a complete manufacturing bill of materials with original manufacturer's part numbers. Do not use in-house, or distributor's stocking part numbers.

D. Control Schedule:

- 1. Submit for approval in spreadsheet format showing control equipment, equipment being controlled and/or monitored with manufacturer's name and model numbers. Include control

and controlled equipment voltages and loads, control switch functions, LED indicators, door interlocks, alarms, integration connections to fully describe the functions and equipment interface. Submit catalog specification sheets on equipment to be provided. Update the control schedule with approved changes made during the project.

2. The control schedule shall be included in the facilities maintenance manual.
- E. Product Data:
1. Submittals shall be presented as a single complete and organized package for review.
 2. The system shall be fully supported with documentation illustrating that complete engineering has been done. Work shall not commence until documentation is completed. The documents shall be original; bid documents shall not be duplicated for submission.
 3. As part of the submittal package, and when required by the manufactured product, a list of special tools, equipment lists, and calibration equipment list shall be provided.
- F. Shop Drawings:
1. Submit for approval equipment elevations, power supply back panels, point-to-point schematic wiring diagrams showing control equipment connections, and controlled equipment interconnections.
 2. Provide sections and/or views as needed to show code-required components, and wire class separations.
 3. Provide field of view drawings for all camera locations.
 4. Use numbered balloons with arrowed lines pointing to typical components to reference the bill of materials.
 5. Utilize the same symbols used on the contract drawings with additional symbols as needed to show device locations, and relationships.
 6. Clearly define symbols on the drawings, including the manufacturer's name, model number, and mounting height.
 7. Indicate specialty cables by manufacturer's model number with a table of information showing cable area, individual conductor types contained, and typical uses for each cable.
 8. Fully dimensioned housing and mounting drawings, including information on finishes.
 9. Submit illustrated system riser diagrams showing equipment in suitable pictured drawing or symbol format with required interconnecting wire or cable indicated including power sources. Include riser locations on plan views showing penetration details, or reference other Sections.
- G. Substantial Completion Submittals
1. Substantial Completion of the VSS System installation shall be the point at which all Equipment has been installed, programmed, configured and initially tested to confirm proper operation. The point of Substantial Completion shall be mutually agreed between Contractor and MCCD and/or MCCD Representative following discussion and observation. At the point of agreed Substantial Completion, Contractor shall submit the following:
 2. Testing Report
 - a. Perform electrical and electronic tests and present documented results as noted herein. Provide results to MCCD and/or MCCD Representative before scheduling the Preliminary Checkout.
 - b. Submit test results in a table format stating test description, acceptable result value and measured value (result). Clearly show all values not in acceptable value ranges.
 - a) Preliminary Project Record Documents Submittal
 - c. Upon Substantial Completion Contractor shall submit Preliminary Project Record Documents to MCCD and/or MCCD Representative. Preliminary Project Record documents shall be submitted prior to the Preliminary Checkout.
 - d. Preliminary Project Record Documents shall include:
 - a) Corrected/updated shop drawings and points schedule that includes a complete and correct system schematic showing wire routes, labeled electric circuits, detailed connections for all parts of the system, including wire

numbers, terminal block numbers and layouts, color-per floor, and all other designations and codes.

- b) Updated Equipment List
- c) Half-size drawings modified to reflect the actual installation conditions.
- d) CD-ROM with manufacturers' operation manuals arranged alphabetically and current drawings in .DWG format.
- e. MCCD and/or MCCD Representative's Preliminary Checkout will be scheduled after the Preliminary Project Record Documents and Test Reports have been approved.

H. Final Acceptance Submittals

1. Prior to Final Acceptance the Integrator shall submit the following:

- a. Hardcopy Project Record Documents
 - a) Product Information Binders which shall consist of all product literature, manuals, software, and other material provided by equipment manufacturers with the Equipment. Material shall be assembled in binders with section dividers and a table of contents.
 - b) Warranty documentation including warranty start and end dates for each individual piece of equipment provided.
 - c) Explanation of procedures for obtaining telephone support and on-site service during Integrator's warranty period.
 - d) Recommended dates for the preventive maintenance service calls.
 - e) Electrical and electronic test results.
 - f) Key schedule with three copies of each key required for operation of the systems, equipment racks, etc.
 - g) One (1) half-size set of all System design drawings revised to reflect "as-built" conditions.
 - h) One (1) full-size set of all System design drawings revised to reflect "as-built" conditions
 - i) Contractor shall provide and place inside of each controller, installed as part of this specification, a copy of the approved (final version) controller programming schedule, and a single-line detail drawing (minimum 11x17) which identifies and shows all connected and unused wiring, system equipment, and devices installed in conjunction with each specific controller as part of the drawing package.

2. Electronic documentation on CD-ROM(s) to include:

- a. Back-up of System software code (e.g., user interface software and control processor program). Un-compiled source code shall be submitted in both soft copy and printed out in hard copy documentation. Copies (hard and soft) of the software are to be included in the systems manuals.
- b. Copies of all custom or purpose-created software, including original source code.
- c. All software shall be written with remark statements to document function of sub-routines, macros, and program requirements.
- d. All control and specific device application software.
- e. All final software configuration and final set-up settings.
- f. Final equipment list with warranty and serial number information.
- g. Record Drawings in .DWG format
- h. Record Drawings in PDF format.
 - a) Drawings for this project must show wiring homeruns and the location of all distribution panels, disconnects, alarm devices, and other electrical equipment installed or utilized by this system. The size and quantity of all wiring must be shown. Final payment for the work performed will not be released until all drawings are received and approved by MCCD and/or MCCD Representative.



- b) In addition to all information required as part of the shop drawing submittal, provide the exact locations of end-of-line supervisory resistors, or supervisory devices as actually installed.

1.8 WARRANTY

- A. Contractor warrants that all Work furnished (material and labor) under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.
- B. Contractor shall provide a parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of one (1) year from date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time. Warranty that extends the period of time over one (1) year shall be inherited by MCCD.
- C. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.
- D. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification, or repair by MCCD, civil unrest, or acts of God.
- E. Provide a Certificate of Warranty to include Site name, date Warranty begins and ends, Service Provider contact information, complete street address and phone number. Contractor and manufacturer(s) shall warranty all equipment, materials, and installation labor for a minimum of one (1) year from the date of written notification of Acceptance by MCCD.
- F. During the Warranty Period, upon notification of a problem by MCCD, the Contractor shall ensure that a competent and qualified field service technician arrives on site to correct the problem within 24 hours of notification. If a problem can be corrected remotely to MCCD's reasonable satisfaction, the on-site arrival time commitment shall be waived.
- G. At least sixty (60) calendar days prior to expiration of Warranty, Contractor shall provide MCCD with post-Warranty maintenance contract proposals. The terms and conditions of any such post-Warranty program shall be consistent with those offered to the provider's most favored customer(s).

1.9 OPERATION AND MAINTENANCE DATA

- A. Maintenance manuals shall include:
 - 1. Record Submittals as outlined above.
 - 2. OEM Manuals for all equipment.
 - 3. A recommended spare parts list.
 - 4. The local source for replacement parts with telephone numbers for contact.
 - 5. Programmers' manuals shall be included in the operation and maintenance manual data package, and shall include:
 - a. A description of keyboard programming functions, the operating system, programming language, system architecture, diagnostic messages, commands, and other programming procedures.
 - 6. Contractor shall provide a set of three appropriately labeled DVD videodiscs, and holder cases for MCCD that will contain the historical record of training.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Products specified are based on performance criteria and may possess features that are not currently intended for use, but may be used in the future under anticipation, and therefore provided for expansion.



- B. All components and systems supplied as part of this specification shall be compatible with the system.
- C. Equipment shall be Underwriter's Laboratory Listed for the intended use.
- D. Low voltage power supplies required to source equipment supplied under this section, other sections, and controlled or monitored by this section shall be appropriately class rated for connected equipment and sized at 50% above expected load.

2.2 VIDEO SECURITY SYSTEM

- A. IP Network Cameras – Interior/Exterior
 - 1. The IP network cameras shall be;
 - a. Exterior High-Resolution Camera – Verkada CD62-E
 - b. Exterior Multi-sensor 360-Degree Camera – Verkada CH52-E
 - c. Interior High-Resolution Camera – Verkada CD62
 - d. Interior Multi-sensor- 360-Degree Camera – Verkada CH52-E
 - e. License Plate Recognition Camera – Verkada CB62-E or CB62-E if telephoto is needed.
 - f. Pan Tilt Zoom Camera – Verkada CP52-E
 - 2. As needed for coverage, the contractor shall be responsible for providing and installing programmable IP dome camera systems as identified on the Project drawings.
 - 3. Camera models noted will be replaced when discontinued with the next consecutive or equal replacement model available from the manufacturer at the time of ordering.
 - 4. Contractor shall perform all tasks to properly install and program each camera system in accordance with the manufacturer's specifications and intentions.
 - a. Camera resolution shall be sized such that the target field of view coverage provides a minimum of 40 pixels per foot. The minimum resolution shall be:
 - a) Exterior Dome Camera – Min. 4K camera for general viewing
 - b) Exterior High-Resolution Camera – Min. 4K camera
 - c) Exterior Camera – Min. 20 MP for general viewing
 - d) Interior Dome Camera – Min. 4K camera for general viewing
 - e) Interior High-Resolution Camera – Min. 4K camera
 - f) Interior Camera – Min. Min. 20 MP for general viewing
 - g) License Plate Recognition Camera – Min. 4K camera for license plate reading.
 - 5. Refer to MCCD Security Camera System Standards document for additional requirements and design considerations.

2.3 DIGITAL VIDEO SECURITY SYSTEM

- A. VSS components provided as part of this scope of work shall be integrated into the Verkada Command platform. Contractor shall provide and install all components as needed to support the system as part of this scope of work.
- B. Contractor shall provide complete, connection, programming, and operation of all system components to the existing Verkada Command platform as part of this Scope of Work Specification. Programming requires coordination with the MCCD IT team including the scanning of the QR code on the camera before installation into the Verkada Command (Cloud) Management System.
- C. Contractors shall coordinate with MCCD IT Team for system upgrades and additions to the Verkada subscriptions required as part of this scope of work.
- D. Video Security and control software to be cloud based Verkada Command, no equal (Sole Source).



2.4 NETWORK VIDEO RECORDER

- A. A traditional Network Video Recorder is not required for this system. The system shall be a cloud-based storage system with local (on-camera) SD-card storage as the backup means of archiving video footage.
- B. The cloud-based system shall be Verkada. No approved equal.
- C. Refer to MCCD Security Camera System Standards document for additional requirements and design considerations.

2.5 COMMUNICATIONS

- A. Provide and install all applicable network communications connections and terminations for each controller installed under these specifications.
- B. Division 16750 Contractor shall provide a network cable and terminated connector (network drop) at each specified controller location installed under these specifications to establish a connection between the controller and the MCCDs Wide Area Network.
- C. The MCCD's IS Department shall provide all applicable Internet Protocol (IP) network configuration information as necessary to establish a connection between each device and the tenant's Wide Area Network.
- D. Terminate and complete all necessary connections and provide all programming to properly establish communications between controller, the MCCD's Wide Area Network and/or Local Area Network, and the specific configured server in which this system is to operate.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment subject to public contact shall be installed with a torx-head or equal security fasteners unless protected by a factory supplied cabinet lock.
- B. Junction boxes, utility boxes, or other electrical enclosures housing system wiring not protected by factory supplied locks shall be installed with a torx-head or equal security fastener.
- C. Interior mounted equipment shall be installed after room finishes have been completed to protect the equipment from contamination.
- D. All wiring performed below ten (10) feet from the ground surface must be performed in approved conduit unless wiring runs are provided within existing wall cavities or above existing drop-ceilings. Open wire runs are permitted from that point.

3.2 LABELING

- A. All labelling shall match the current MCCD cabling standards per specification 271000.
- B. All wiring to and from each device and/or component, i.e., communications wiring, alarm point wiring, power wiring, etc. must be properly labeled in accordance with this section.
- C. All wiring/cabling must be provided at each end with a MCCD-approved label, which identifies what it is by means of input or output number, port number, or specific identification to properly identify it in relationship with the system and in accordance with all project blueprints.
- D. All wiring labels must be physically attached to the wiring. Specific methodology and location for all labeling must be approved by MCCD prior to usage. All labels must be produced in a legible typed format at least No. 6 Arial Font or equivalent. Hand-written labels are not permitted.
- E. Wiring labels must be provided and readily identifiable/readable from within each system panel and shall be in a position in which it can be readily read and not hidden or gathered within bundled cables/wires secured with such items as tie-straps.
- F. Wiring labels for equipment and devices that are specified or required to be mounted or suspended in high locations, which are not reasonably accessible with the use of a standard



ladder, not taller than eight (8) feet in height, shall be attached to the associated wiring at a practical location which would allow the label to be read without going to the associated device. In such instances where wiring labels are attached in this manner the contractor shall additionally attach a stand-off plastic "flag or tag" of some nature to the associated wiring at the location of the wiring label. The tag or flag shall be readily identifiable to the associated device in which it is being used. The tag or flag shall be labeled with the word "Wiring Label" or the associated wiring label information in a practical font size associated with the flag or tag which has been installed. All such flags or tags used for this application must be approved by MCCD prior to usage.

- G. Contractor must provide a wiring scheme detail identifying all wiring labels and their association within the system.

3.3 WIRING

- A. Provide, install, connect, and terminate all system required power, communications, and carrier wiring for all equipment and devices installed as part of this Scope of Work Specifications. The contractor is responsible for determining and providing appropriate wire including appropriate conductor sizing, shielding, and required gauges for all installations and applications associated with this project.
- B. All system wiring must be manufacturer approved and installed and terminated in accordance with the manufacturer's specifications and run in a neat and workmanship-like manner.
- C. Contractor is responsible for providing and installing all appropriate wiring for the existing environment and inherent conditions for all areas including those which are plenum rated.
- D. All wiring must be run inside any existing walls where and whenever possible.
- E. All wiring runs below ten (10) feet from the ground surface shall be run in approved conduit unless installed within existing or new constructed walls or raceways.
- F. Open wire runs are permitted above ten (10) feet and/or above existing suspended drop-ceilings and must be securely fastened to the structure, but must not be attached to other conduit, drop ceiling support wiring, gas, water, or fire sprinkler line pipes. Appropriate wire ring clips must be utilized for proper installation.
- G. Under no circumstances shall stick-on type fasteners be utilized, or any other type of device that utilizes glue as the only means of securing wiring, relays, or other similar type devices inside of any system panel. Any existing or added stick-on wiring tabs shall be additionally secured to the enclosure with an appropriately sized metal screw.
- H. All wiring shields must be properly tied down in accordance with applicable electrical code and industry standards.
- I. Standard wire shall be terminated with solderless, crimp-on, or insulated lugs properly sized for the gauge of wire and screw or push-on connection. The use of clamp type terminal connections is permitted. Pigtail and wire-nut connections are only permitted when equipment is supplied by the manufacturer in that manner as the only means of connection.
- J. Video cables shall not be spliced without the use of video signal amplification equipment at the splice point when such video systems are applicable.

3.4 PROGRAMMING

- A. Contractor shall incorporate and provide all monitoring aspects associated with the proper installation for each camera as part of these specifications in accordance with the manufacturer's specifications and intentions.
- B. Contractor shall be responsible for coordinating, performing, and completing all system and/or manufacturer specified programming associated with this project and shall coordinate system programming through MCCD.

- C. Programming shall include incorporation and/or configuration of all associated records and/or databases necessary for proper operation and functionality of the intended project.
- D. Programming shall include providing, creating, incorporating, and configuring user interactive system display screens for cameras installed under these specifications.
- E. Contractor shall be responsible for scheduling all system testing with the concurrence of MCCD.
- F. The installed system will be subject to performance testing and acceptance inspection upon installation. Performance testing and acceptance inspection will be completed within ten working days after installation. Engineer will not make final system acceptance until the vendor has provided all submittals; blueprints (final "AS-BUILTS") as described within Section PART 1. Upon completion of each location, Contractor shall contact MCCD for a project walkthrough. Contractor shall provide a finalized print to the Engineer for the final walkthrough. This walkthrough shall include, but not be limited to, testing of all:
 - 1. Cameras
 - 2. Field of view verification
 - 3. All wiring associated with the system.
 - 4. Labeling
 - 5. Programming and Functionality of overall Security Camera System.

3.5 ACCEPTANCE

- A. Closeout procedure: In accordance with Division 1.

3.6 PERSONNEL TRAINING

- A. Contractor shall provide 10 hours of training for the operational staff at the project facility, to be scheduled by MCCD Project Manager. Contractor shall provide training personnel that are thoroughly familiar with the Security equipment and application installed on this project, and the correct methods of operation. All training sessions shall be recorded and provided to MCCD via portable USB drive and/or access portal/FTP in .MOV, .WMA or .MPG form for future use or posting to operational link for staff support.
- B. Maintenance staff training sessions shall include a complete review of maintenance manuals with questions, and answer periods. Questions and answers shall be recorded on digital media for inclusion as part of the manuals package. Conduct a facility tour to include explanation and visual observation of wire/cable routing, and identification of, connections to, and identification of equipment. In addition, follow signal paths using schematic diagrams with appropriate test equipment to perform troubleshooting, and identification of failed components or equipment. Simulate failures of equipment and demonstrate troubleshooting methods.

END OF SECTION 28 23 00



SECTION 28 31 11
DIGITAL ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Fire detection and alarm system.
 - 2. Fire alarm control panel (FACP) compatible with the existing CAMPUS Fire Alarm Monitoring Station.
- B. Related Sections:
 - 1. Division 7 Section "Firestopping."
 - 2. Division 23 Mechanical sections, for fan and smoke control.
 - 3. Division 26 Electrical sections, for general electrical requirements, conductors, conduit and raceway.

1.2 DEFINITIONS

- A. Where this Section references CALIFORNIA STATE Fire Marshal involvement, the Contractor's contact with the CAMPUS Fire Marshal shall be via the College's Representative. All documents and other materials shall be submitted to the College's Representative.
- B. Whenever the term "system" is used herein without additional modification, it shall be taken to mean the fire detection and alarm system. The system shall be as defined in Section 204(c), Title 19, California Code of Regulations. It shall not be construed as including auxiliary circuits such as those associated with elevator recall, elevator machine electrical power disconnection, fan and smoke control system controls/devices, magnetic door hold-open release relays, and/or automatic-closing doors.
- C. Unless otherwise specified, all system circuits (including, but not limited to initiating device, notification appliance, and relay circuits) shall be considered to start and end at the FACP.

1.3 PERFORMANCE REQUIREMENTS

- A. The entire system shall conform to Titles 8, 19, and 24; California Code of Regulations, including all referenced standards. All equipment shall be UL Listed, FM-approved, and currently listed by the California State Fire Marshal.
- B. At the minimum, include the following:
 - 1. Provide an FACP and main fire alarm terminal cabinet (MFATC), as specified herein and as indicated on the drawings. Provide additional fire alarm terminal cabinets (FATCs), as specified herein, in the additional locations specified herein and as indicated on the drawings.
 - 2. Provide smoke, heat, and duct-mounted smoke detectors, and manual pull stations, as specified herein and as indicated on the drawings. Provide monitoring of all automatic fire sprinkler waterflow switches and control valve tamper switches. "Tampered cover option" switches shall be monitored separately from valve position or waterflow switches.
 - 3. Provide audible/visual notification appliances and visual notification appliances, as specified herein, throughout the facility as indicated on the drawings and/or in accordance with ADA requirements.
 - 4. Provide a visual annunciator with legend, as specified herein and as indicated on the drawings.
 - 5. Provide duct-mounted smoke detectors in the main supply-air duct(s) to effect shutdown of each air handler rated at supplying more than 2000 CFM. Provide duct-mounted smoke detectors to actuate smoke/fire dampers as shown on the drawings.
 - 6. Provide a building location strobe light, as specified herein and as indicated on the drawings.
 - 7. Provide a smoke detector to protect every fire alarm control unit (including, but not limited to: the main fire alarm control panel, every additional fire alarm control panel, every transponder panel, every auxiliary power supply, and every notification appliance power extender).



1.4 SUBMITTALS

- A. Approval from the College's Representative and CALIFORNIA STATE Fire Marshal must be obtained for all components of the system submittal (including but not limited to: system contractor qualifications, material data sheets, and shop drawings). Submittals having any content which is incomplete or unclear will be returned without review or approval. If all components of the system submittal have not been approved due to Contractor's incompleteness or errors, the College shall have the right to require the Contractor to cancel the system contractor's contract and to engage the services of a substitute system contractor at Contractor's expense.
- B. Submit catalog data sheets for all materials. Submit factory installation manuals/sheets for each component to be installed in the system. Data sheets/factory installation manuals/sheets are required for all system components, including but not limited to: control units, batteries, battery chargers, initiating devices, audible notification appliances, visual notification appliances, annunciators, terminals, cabinets, enclosures, conduit, wiring conductors, and relays. All equipment drawing alarm or supervisory current shall have documentation of the current draw highlighted in the submittal information. Submittals shall include State Fire Marshal Listing Sheets, including listing number with annual update and expiration date, for every system component. Submittals will be automatically rejected if complete listing information does not accompany submittal.
- C. In addition, submit one original copy of the latest edition of the operation, maintenance, and installation manual(s) (whichever exist) for each FACP submitted. This is to be-forwarded directly to the Fire Marshal.
- D. Submit shop drawings.
- E. After approval of the above materials submittal, submit installation shop drawings, prepared by a designer who has been factory-trained on the specified FACP. Working drawings shall be submitted in complete sets (partial submissions will not be accepted). Working drawings shall include, at a minimum:
 - 1. Title sheet, which includes a sheet index, a scaled site plan, an initiating device signaling line circuit address list, a notification appliance circuit chart, a combination parts list/symbol legend, an annunciator zone schedule, and an annunciator legend (where applicable).
 - 2. Standby power battery calculation(s).
 - 3. Complete riser diagram.
 - 4. Complete point-to-point wiring schematics.
 - 5. Proposed conduit layout plan showing the actual routing of the conduit, the size and specific wires in each segment of conduit, the location of every device, module, and terminal cabinet (including identification of the initiating device/notification appliance circuit to which each is connected), the address of each addressable device, the location of all partitions, and the name and/or room number of each area or room. Where conduit will be installed within concealed spaces for which no access will be provided, the conduit routing layout must be scalable.
 - 6. Interior elevations of each room where one or more FACPs, FATCs, battery cabinets/chargers, auxiliary power supplies and/or other control devices are located. Include details of manner of installation for any equipment weighing more than 20 pounds.
 - 7. Voltage drop calculations for each notification appliance circuit. Calculations shall be based on 24 VDC, with high-level volume/level used for horns, and average current used for strobes.
- F. Operation and Maintenance Manuals: Submit two (2) manuals, each of which shall include all instructions necessary for operation and required maintenance of the system, complete circuit diagrams, wiring and termination schedule for each circuit entering and on leaving each piece of equipment, schematic diagrams of each major component, including a replacement parts list with part numbers, name, and telephone number of local supplier. Include any portions of the material list and shop drawings which are not included in the foregoing.
- G. Certification: Provide a Fire Alarm System Record of Completion as per Section 1-6.2.1, NFPA 72 (2010).
- H. Record Drawings: Submit four sets of Record Drawings, which shall be sufficiently complete as to facilitate trouble shooting and repair of the system, as follows: one (1) set shall be black-line Mylar reproducibles, two (2) sets shall be blue-line (or equal) reproduction copies, and one (1) set shall be on



an MS-DOS-formatted CD-ROM in AutoCAD, Release 14 (or higher) ".DWG" format with no "X-Refs". Final approvals are subject to receipt of acceptable Record Drawings. In particular, the Drawings shall identify every change of wiring/conduit direction accomplished by other than bending, including, but not limited to: junction boxes, pull boxes, "LB"s, "LL"s, "LR"s, entrance "L"s. Submittal of a single blue-line (or equal) reproduction draft copy for review prior to the final submission is encouraged. Provide two copies of the MS-DOS-formatted CD-ROM containing the backed-up programming as required.

1.5 QUALITY ASSURANCE

- A. Installer and Fabricator Qualifications:
1. The system contractor shall hold a current California C-10 contractor's license, and shall have held this license, under the currently-licensed business name, for a period of not less than five years as of the date of bidding the job.
 2. Submit evidence of the system contractor's current California C-10 contractor's license and list of minimum three comparable installations completed within the last five years.
 3. The system contractor shall demonstrate satisfactory installations of comparable systems over a period of not less than five years immediately preceding the date of bidding this job, including references (name, email and telephone no.)
 4. The system contractor shall be a factory-authorized distributor of the manufacturer of the specified FACP, and shall have been so continuously for a period of not less than five years as of the date of bidding the job. Additionally, the system contractor shall employ design personnel and installation technicians who have been factory-trained on the specified FACP.
 5. The system contractor shall prove the ability to provide emergency restoration service within 12 hours by factory-certified personnel.
 6. The system contractor shall be capable of providing drawings in AutoCAD, Release 14 (or higher), format.
- B. The system specified herein and as described on the Drawings (including but not limited to materials, design, installation and testing) shall be provided by a single contractor, identified hereafter as the "system contractor," qualified as described below.

1.6 COORDINATION

- A. The Contractor shall be specifically responsible for ensuring that no system components (including but not limited to: conduit, wire, terminal cabinets, junction boxes and/or device boxes) shall be installed prior to their having been detailed on approved shop drawings. The Contractor shall be specifically responsible for ensuring that coordination between the system work and the fire protection system work takes place to ensure full awareness of the location of all fire protection system components (including, but not limited to control valves, flow switches and tamper switches) requiring connection to the system. Further, the Contractor shall be specifically responsible for ensuring that coordination between the system work and other work takes place to ensure full awareness of the location of all components/devices requiring connection to the system (including, but not limited to: fan and smoke control system controls/devices, magnetic door hold-open release relays, and automatic-closing doors).

PART 2 - PRODUCTS

2.1 GENERAL SYSTEM REQUIREMENTS

- A. The Contractor shall furnish and install a complete supervised microprocessor-controlled, intelligent reporting fire detection and alarm system consisting of one or more FACP's, FATC's, initiating devices, notification appliances, relay modules, FATC's, batteries and battery cabinets, annunciator panels, metallic conduit, boxes, wiring, and other components as required for a functional system.

2.2 MANUFACTURERS

- A. Equipment shall be manufactured by Notifier (to match College standard). All major equipment (including, but not limited to initiating devices, notification appliances, and control elements) shall be the product of the manufacturer of the FACP.
1. Exception: Provide College's standard devices where specified or required.



2.3 FIRE ALARM CONTROL PANEL

- A. The fire alarm control panel shall be manufactured by Notifier to match College standard, (Model 320, 640, 3030 Voice Evac or NFC50/100 Voice evac Panel) capable of meeting the performance requirements herein. It shall contain a microprocessor based central processing unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, annunciators, and other system controlled devices.
- B. Function: The main FACP shall perform the following functions:
 - 1. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
 - 2. Supervise all initiating device, notification appliance, power, control, and signaling circuits throughout the facility by way of connection to monitor and control modules.
 - 3. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed.
 - 4. Visually and audibly annunciate any trouble, supervisory or alarm condition on operator's terminals, control panel display, and annunciators.
 - 5. Code Generator: The FACP shall incorporate a solid-state audible signal code generator capable of generating the three-pulse temporal pattern (as defined in ANSI S3.41/ISO 8201) signal.
- C. System Capacity and General Operation:
 - 1. The FACP shall provide, or be capable of expansion, to not less than 127 intelligent/addressable devices per loop and not less than 254 annunciation points per system.
 - 2. The FACP shall include a full featured operator interface control and annunciation unit that shall include a backlit, 80 character liquid crystal display, individual, color coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system.
 - 3. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the FACP.
 - 4. The FACP shall be able to provide the following features:
 - 5. Block Acknowledge.
 - 6. Charger Rate Control.
 - 7. Control-By-Time.
 - 8. Automatic Day/Night Sensitivity Adjust.
 - 9. Device Blink Control.
 - 10. Drift Compensation.
 - 11. Pre-alarm Control Panel Indication.
 - 12. NFPA 72 Smoke Detector Sensitivity Test.
 - 13. System Status Reports.
 - 14. Alarm Verification, by device, with tall.
 - 15. Multiple Printer Interface.
 - 16. Multiple CRT Display Interface.
 - 17. Non-Alarm Module Reporting.
 - 18. Periodic Detector Test.
 - 19. Trouble Reminder.
 - 20. Upload/Download to PC Computer.
 - 21. Alarm Verification with Tally.
 - 22. Walk Test.
 - 23. Smoke Detector Maintenance Alert.
- D. Voice Evacuation/Mass Notification Control Panel:
 - 1. The Voice Evacuation/Mass Notification Control Panel shall be a NOTIFIER FirstCommand NFC-50/100 and shall contain a microprocessor-based Central Processing Unit (CPU). The CPU shall distribute and control emergency voice messages over the speaker circuits.



2. The system shall provide the capability to interface to LOC (Local Operator Console), Distributed Audio Amplifiers, Remote Page Unit, Remote Microphone, Fire Fighter Telephone Unit and Remote Telephone Zone Module from the same manufacturer.
3. Shall have as minimum requirements:
 - a. Integral 50 Watt, 25 Vrms audio amplifier with optional converter for 70.7 volt systems. The system shall be capable of expansion to 100 watts total via the insertion of an additional 50-watt audio amplifier module (can be used as a backup amplifier) into the same cabinet. With the addition of optional circuit expander modules and remote Distributed Amplifiers the system can be expanded up to 24 speaker circuits and 1100 watts.
 - b. Speaker circuit that can be wired both Class A and B.
 - c. Integral Digital Message Generator with a memory capacity for up to 60 seconds per messaging. The Digital Message Generator shall be capable of producing fourteen distinct messages (60 seconds each). Field-selectable message and custom message recording capability using the local microphone, a USB port, or an external audio input.
 - d. Built in alert tone patterns with ANSI, March Code, California, Steady, Alert Tone, Hi-Lo, ANSI Whoop, Continuous Whoop, or No Tone is field programmable. Tone Prior to transmitting a message, the Voice Evacuation/Mass Notification Control Panel can be programmed to produce a pre-announce and post-announce tone.
 - 1) Leading Tone Duration If a pre-announce tone is desired; select the length of time it will play before a message is broadcasted. Select 4, 8, 12, 16, 20, 24, or 28 seconds. In a pre-announce tone is not desired, select 0 seconds.
 - 2) Trailing Tone Duration Select the length of time for the post-message announcement tone. Select 4, 8, 12, 16, 20, 24, 28, or 32 seconds from the drop-down menu.
 - 3) Repeat Cycle Select the number of times the message will be repeated during an alarm. A message can be repeated 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, or an Infinite amount of times.
4. The Voice Evacuation/Mass Notification Control Panel will be capable of detecting and annunciating the following conditions: Loss of Power (AC and DC), System Trouble, Ground Fault, Alarm, Microphone Trouble, Message Generator Trouble, Tone Generator Trouble, and Amplifier Fault.
5. The Voice Evacuation/Mass Notification Control Panel shall be fully supervised including microphone, amplifier output, message generator, speaker wiring, and tone generation.
6. Speaker outputs shall be fully power-limited.
7. Amplifiers will be supplied power independently to eliminate a short on one circuit from affecting other circuits.
8. The Voice Evacuation/Mass Notification Control Panel will provide full supervision on both active (alarm or music) and standby conditions.
9. With the addition of an optional internal amplifier and a circuit expander module the main NFC-50/100 can be configured for up to 100 watts and 8 speaker circuits.
10. Optional distributed amplifiers shall be available to expand the system with up to 24 speaker circuits up to 1100 watts.
11. Wiring terminals shall be removable terminal blocks (Wire Gauge 12 – 18 AWG) for ease of servicing.
12. Voice Evacuation/Mass Notification Control Panel will provide 2 amp Notification Appliance Circuit (NAC) output with sync generator or follower for System Sensor, Wheelock or Gentex protocols. The NAC shall be capable of One (1) Style Y (Class B) or Style Z (Class A) circuit.
13. Shall have eight Command Input Circuits to activate messages via reverse polarity or contact closures.
14. Built in External Audio Input can be used for background music.
15. On-board battery charger which supports charging up to 26 AH batteries (cabinet holds up to 18AH batteries).
16. Programmable delay of immediate, 2 hours or 6 hours reporting of AC Loss.
17. Built in Piezo sounder for local trouble.



18. Stores the events in the 100 Event History log.
 19. Shall have Console Lamp Test switch and shall activate all system LEDs including Remote Consoles.
 20. Shall have three Form-C relays:
 - a. AC Power Loss Relay
 - b. System Trouble Relay
 - c. MNS Active (For Mass Notification signage)
 21. Shall have a Special Application (auxiliary power) output for addressable modules when interfaced with compatible addressable FACP's and End-of-Line power supervision relays.
 22. Shall be capable of Speaker Volume Control. The Supervised Volume Control will allow manual volume setting for telephone paging and background music for a specific speaker or speaker zone.
 23. Shall have a Night Ring input allows a building's Private Branch Exchange (PBX) to activate the Voice Evacuation/Mass Notification panel.
 24. The Voice Evacuation/Mass Notification panel can communicate in any combination up to eight (8) external remote consoles:
 - a. Optional Remote Microphone
 - b. Optional Remote Page Unit
 - c. Optional Local Operator Console
 25. The Voice Evacuation/Mass Notification panel can communicate in any combination up to eight (8) external distributed audio amplifiers:
 - a. Optional Distributed Amplifier, 50 watts.
 - b. Optional Distributed Amplifier, 125 watts.
 26. Shall be capable of integrating with firefighter telephone system that provides secure and reliable communications. The firefighter telephone system will allow for up to ten users to plug in to a remote telephone jack and communicate simultaneously within a building.
 27. Shall be capable of secure access to the Voice Evacuation/Mass Notification panel via cell phone or other remote telephone.
 28. The Voice Evacuation/Mass Notification panel can be integrated by an FACP via the ANN/ACS (EIA-485) link. Compatible FACP's include the NFS-320, NFS2-640 and the NFW2-100 (FireWarden-100-2).
 29. The Voice Evacuation/Mass Notification panel integrates with the NFS-320, NFS2-640 and the NFW2-100 (FireWarden-100-2) will report Mass Notification events to the Central Station.
 30. The Voice Evacuation/Mass Notification panel can be interfaced with other UL Listed Fire Alarm Control Panels via activation of reverse polarity or by contact closure.
- E. Speakers:
1. All speakers shall operate on 25 or 70 VRMS with field selectable output taps from 0.25 to 2.0 Watts.
 2. Speakers in corridors and public spaces shall produce a minimum sound levels of 75 dBA output at 10 feet (3m).
 3. The plug-in speaker allows the installer to pre-wire mounting plates and dress the wires before plugging in the speakers.
 4. Flush mount applications are achievable without the need for an extension ring.
 5. Frequency response shall be a minimum of 400 HZ to 4000 HZ.
 6. Rotary switch simplifies field selection of speaker voltage and power settings.
- F. Enclosures:
1. The Voice Evacuation/Mass Notification panel shall be housed in a UL-listed cabinet suitable for surface mounting. The cabinet and front shall be corrosion protected and painted red via the powder coat method with manufacturer's standard finish.
 2. The back box and door shall be constructed of steel with provisions for electrical conduit connections into the sides and top.
 3. The door shall provide a key lock and shall provide for the viewing of all indicators.
- G. Central Processing Unit (CPU):



1. The CPU shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the CPU.
 2. The CPU shall contain and execute all control-by-event (including AND-ing, OR-ing, NOT-ing, CROSSZONE-ing) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure.
 3. The CPU shall provide a real-time clock for time annotation of all system displays. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.
- H. Display:
1. The system display shall provide all the controls and indicators used by the system operator and may be used to program all system operational parameters.
 2. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.
 3. The system display shall provide an 80-character back-lit alphanumeric liquid crystal display (LCD). It shall provide light-emitting-diodes (LEDs) that will indicate the status of the following minimum system parameters: AC POWER, SYSTEM (FIRE) ALARM, and SYSTEM TROUBLE.
 4. The system display shall provide a touch key-pad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. A minimum of two different password levels shall be accessible through the display interface assembly to prevent unauthorized system control or programming.
 5. The system display shall include the following minimum operator control switches: (ALARM) ACKNOWLEDGE, SIGNAL (ALARM) SILENCE, and (SYSTEM) RESET.
- I. Signaling Line Circuit (SLC) Interface Board:
1. Each SLC board shall monitor and control a minimum of 127 intelligent addressable devices. This includes analog detectors (ionization, photoelectric, or thermal), monitor, and control modules.
 2. The SLC interface board shall contain its own microprocessor, and shall be capable of operating in a local mode (any SLC input activates all or specific SLC outputs) in the unlikely event of a failure in the main CPU of the control panel.
 3. The SLC interface board shall not require any jumper cuts or address switch settings to initialize SLC operations.
 4. The SLC interface board shall provide power and communicate with all intelligent addressable detectors and modules connected to its SLC on a single pair of wires. The SLC shall be capable of operation as NFPA Style 4 or Style 6, and capable of near-NFPA Style 7 operation using isolator modules.
 5. Each SLC interface board shall be able to drive at least one Class A (NFPA Style 6) circuit capable of communicating with a device at least 2,500 feet from the FACP, and capable of communicating over a total of 10,000 feet of wire.
 6. The SLC interface board shall receive analog information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular detector. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may be used for automatic detector testing and for the automatic determination of detector maintenance requirements.
- J. Serial Interface Board:
1. A serial interface board shall provide an EIA-232 interfaces between the FACP and the UL Listed electronic data processing (EDP) peripherals.
 2. The serial interface board shall allow the use of multiple printers, CRT monitors, and other peripherals connected to the EIA-232 ports.



3. The serial interface board shall provide at least one EIA-485 port for the serial connection to annunciation and control subsystem components.
 4. The serial interface board shall have LEDs that will show that it is in regular communication with the annunciators or other EIA 485 connected peripheral device.
 5. EIA-232 serial output circuits shall be optically isolated to assure protection from earth ground.
- K. Enclosures:
1. The FACP shall be housed in a UL Listed cabinet suitable for surface or semi-flush mounting. Cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
 2. The back box and door shall be constructed of minimum 0.060-inch steel with provisions for electrical conduit connections into the sides and top.
 3. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be hinged on either the right or left side (field selectable).
 4. The control panel shall be modular in structure for ease of installation, maintenance, and future expansion.
- L. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.
- M. The CPU and associated equipment are to be protected so that they will not be affected by voltage surges or line transients consistent with UL Standard 864.
- N. Each peripheral device connected to the CPU shall be continuously scanned for proper operation. Data transmissions between the CPU and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques.
- O. Main Power Supply (MPS):
1. The MPS shall operate on 120 VAC, 60 Hz, and shall provide all necessary power for the FACP.
 2. The MPS shall provide a minimum of 3.0 amps of usable notification appliance power, using a switching 24 VDC regulator.
 3. The MPS shall be expandable for additional notification appliance power in minimum 3.0 amp increments.
 4. The battery charger portion of the MPS shall be UL Listed as having the capacity to maintain the battery fully charged with automatic rate change.
 5. The MPS shall provide a very low frequency sweep earth detect circuit, or an approved equivalent means, capable of detecting earth faults on sensitive addressable modules.
 6. The MPS shall be power-limited using positive temperature coefficient resistors or an approved equivalent means.
 7. The above requirements apply equally to any supplementary and/or auxiliary power supplies determined necessary to fully power the system, as well as to the annunciator power supply.
- P. System Circuit Supervision:
1. The FACP shall supervise all circuits to intelligent devices, annunciators and conventional peripherals and annunciate loss of communications with these devices. The CPU shall continuously scan the above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate that device or devices are not responding.
 2. Sprinkler system control valves, standpipe control valves, post indicator valves, and main gate valves shall be supervised for off-normal position.
- Q. Field Wiring Terminal Blocks: For ease of service all wiring terminal blocks shall be the plug-in type and have sufficient capacity for 18 to 12 AWG wire. Terminal blocks permanently fixed are not acceptable.
- R. Municipal Tie Modules: A reverse-polarity module shall be provided for transfer of system alarm and trouble signals to the CAMPUS Fire Alarm Monitoring Station via campus fire alarm proprietary cable



plant, with connection point at the main FATC. The contractor shall coordinate connection of this function with the College's Representative.

1. The normal polarity output current of the module shall be interrupted on all trouble (including supervisory) conditions, including loss of AC power, without reliance on batteries or other secondary power sources. The output polarity shall reverse on all alarm conditions and shall supersede any output current interruption due to trouble conditions. A remote station disconnect switch is required which, when operated, shall interrupt the output current irrespective of alarm conditions.
- S. Field Programming:
1. The system shall be programmable, configurable and expandable in the field without the need for special tools or electronic equipment and shall not require field replacement of electronic integrated circuits.
 2. All programming shall be accomplished either through the standard FACP keyboard or using DOS-based or Microsoft Windows-based software on a standard PC-compatible laptop computer.
 3. All field-defined programs shall be stored in non-volatile memory.
 4. The programming function shall be enabled with a password that may be defined specifically for the system when it is installed. A minimum of two levels of password protection shall be provided. One level shall be used for status level changes such as zone disable or manual on/off commands. A second (higher level) shall be used for actual change of program information.
 5. System programming shall be "backed-up" on one or more MS-DOS formatted CD-ROMs. This system back-up shall be capable of download to a replacement FACP should the system be damaged due to fire or other event.
- T. Specific System Operations:
1. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent smoke detectors in the system from the system keypad or from the keyboard of the video terminal. Sensitivity range shall be within the allowed UL window.
 2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification function shall be programmable from 5 to 30 seconds and each detector shall be able to be selected for verification during the field programming of the system or anytime after system turn-on. Alarm verification shall not require any additional hardware to be added to the control panel. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
 3. System Point Operations:
 4. Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad.
 5. System output points shall be capable of being turned on or off from the system keypad.
 6. Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:
 7. Device Status.
 8. Device Type.
 9. Custom Device Label.
 10. Software Zone Label.
 11. Device Zone Assignments.
 12. Analog Detector Sensitivity.
 13. All Program Parameters.
 14. System History Recording and Reporting: The FACP shall contain a history buffer that shall be capable of storing not less than 400 system output/input/control activations. Each of these activations shall be stored and time and date stamped with the actual time of the activation, until an operator requests that the contents be either displayed. Contents of history buffer shall be manually reviewable, one event at a time, and the actual number of activations shall be capable of being displayed.



15. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable.
16. Automatic Detector Maintenance Alert: The FACP shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.
17. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system shall enter the trouble mode, and the particular intelligent detector shall be annunciated on the system display. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
18. The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80 percent of its alarm threshold.
19. Battery Charge/Transfer Module: Loss or brown-out of main power to the system shall automatically cause the system to transfer to battery power. Emergency power conditions shall be indicated by a lamp and audible annunciator. Upon return of system power, the control panel shall recharge batteries to full capacity within 48 hours following a discharge cycle as specified in 2.13 herein, and maintain battery on float charge thereafter. The charger shall be UL Listed as having the capacity to maintain the battery fully charged with automatic rate change.

2.4 MANUAL FIRE ALARM STATIONS

- A. Manual fire alarm stations shall be rectangular, with a white "T" handle, the handle to pull out and down in an arc with a bottom pivot; single-pole single-throw gold-plated contacts with circuit connections via terminal block; operated stations to be readily distinguishable from front or side, reset to be accomplished with the College standard key. Stations must be designed so that after an actual activation, they cannot be restored to normal except by key reset. Manual stations shall be red with white-finished raised "FIRE ALARM" lettering, and shall be designed for semi-flush mounting, with the exception of the manual stations for use in locations requiring weatherproof devices, which shall be designed for surface mounting.
- B. Manual stations shall be push double action type or lift and pull double action type.

2.5 SMOKE DETECTORS

- A. Smoke detectors shall be intelligent addressable devices, and shall connect with two wires to an SLC.
 1. Exception: Beam smoke detectors may be conventional devices, provided with monitoring modules and power supervision.
- B. The detectors shall use the photoelectric (light-scattering) principle to measure smoke density and shall, on command from the control panel, send data to the control panel representing the analog level of smoke density.
- C. The detectors shall be ceiling-mount and shall include a twist-lock base.
- D. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
- E. The detectors shall provide an address-setting means using decimal or binary (DIP) switches on the detector head or base. The detectors shall store an internal identifying code that the control panel shall use to identify the type of detector.
- F. The detectors shall be provided with at least one alarm/power LED. The LED(s) shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel. The LED(s) may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LED(s) shall be controlled through the system field program. An output connection shall be provided in the base to connect an external remote alarm LED. Remote alarm LEDs shall provide, in a unit capable of installation in a single-gang backbox, a remote visual indicator of alarm status of a connected detector.



- G. The detector sensitivity shall be set through the FACP, adjustable in the field through the field programming of the system. Sensitivity may be automatically adjusted by the control panel on a time-of-day basis.
- H. Using software in the FACP, the detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be UL Listed as meeting the calibrated sensitivity test requirements of NFPA Standard 72.
- I. The detector shall be available with bases with internal sounders, which, upon receipt of a command from, or supply of power from the FACP, shall generate a continuous audible alarm.

2.6 DUCT SMOKE DETECTORS AND DETECTOR HOUSINGS

- A. Duct smoke detectors shall be listed for operation at a minimum airflow of 100 feet per minute.
- B. Each duct smoke detector housing shall accommodate an intelligent addressable photoelectric sensor which provides continuous analog monitoring and alarm verification from the control panel.
 - 1. Exception: use of housings accommodating conventional 4-wire detectors may be permitted when provided with appropriate monitoring devices and other components as required to comply with 3.2.1.8.
- C. Duct smoke detectors shall provide for full cross-sectional sampling of the duct. Auxiliary alarm dry contacts shall be provided.
 - 1. Exception: where duct size precludes installation of a sensor installed in an external housing, an in-duct sensor housing may be used. A remote alarm led as per 2.4.6 shall be provided.
- D. Remote alarm LED/test stations shall provide, in a single unit capable of installation in a single-gang backbox, a remote visual indicator of alarm status of a connected detector, and a switch, capable of being operated with a key, magnet, or other approved tool, to initiate an alarm condition in the connected detector. Remote alarm LEDs shall be essentially identical, except without the test switch. Where use of a key is required, it shall be the College standard key.

2.7 SYSTEM HEAT DETECTORS

- A. Heat detectors shall be intelligent addressable devices, and shall connect with two wires to an SLC.
- B. The detectors shall use an electronic sensor to measure thermal conditions caused by a fire and shall, on command from the FACP, send data to the control panel representing the analog level of such thermal measurements.
- C. The detectors shall be ceiling-mount and shall include a twist-lock base.
- D. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the FACP. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the FACP.
- E. The detectors shall provide an address-setting means using decimal or binary (DIP) switches on the detector head or base. The detectors shall store an internal identifying code that the control panel shall use to identify the type of detector.
- F. The detectors shall be provided with at least one alarm/power LED. The LED(s) shall flash under normal conditions. In certain applications, the LED(s) may be selected to be polled without flashing through system programming. The LED(s) may be placed into steady illumination by the FACP, indicating that an alarm condition has been detected.
- G. An output connection shall be provided in the base to connect an external remote alarm LED.

2.8 MONITOR MODULES

- A. Each monitor module shall be capable of monitoring one supervised Style D (Class A) Initiating Device Circuit (IDC) consisting of one or more of conventional alarm initiating devices (any N.O. dry contact device).



- B. Monitor modules shall have integral mounting brackets, and be capable of being mounted in a 5-inch square, 2.125-inch deep electrical box or surface-mounted backbox. Screw terminals shall be provided for connections to the SLC and the device(s) being monitored.
- C. The monitor module shall provide address-setting means using decimal or binary (DIP) switches and shall store an internal identifying code that the FACP shall use to identify the type of device. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
- D. For connection to shorting-type manual fire alarm stations, monitor modules shall be available in a miniature package capable of being installed within a single-gang box in conjunction with a manual pull station. This version does not require an LED.

2.9 CONTROL MODULES

- A. Addressable control modules shall be capable of supervising and controlling the operation of one conventional Notification Appliance Circuit (NAC) of compatible, 24 VDC powered, polarized audible/visual notification appliances. In addition, for fan shutdown and other auxiliary control functions, the control module shall be capable of operating as a dry contact relay.
- B. Control modules shall have integral mounting brackets, and be capable of being mounted in a 5-inch square, 2.125-inch deep electrical box or surface-mounted backbox. Screw terminals shall be provided for connections to the SLC and the device(s) being controlled.
- C. Control modules shall be capable of being wired for a Style Z (Class A) NAC (up to 1 amp of inductive audible/visual notification appliance, or 2 amps of resistive audible/visual notification appliance) operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to ensure that 100 percent of all auxiliary relay or NACs are energized at the same time on the same pair of wires.
- D. The control module shall provide address-setting means using decimal or binary (DIP) switches and shall store an internal identifying code that the FACP shall use to identify the type of device. An LED shall be provided that shall flash under normal conditions, indicating that the control module is operational and is in regular communication with the control panel.
- E. The control module shall incorporate a magnetic test switch to test the module without opening or shorting its NAC wiring.

2.10 ISOLATOR MODULES

- A. Line-powered isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC. See 3.2.1.7 for required isolator module installation.
- B. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section of the SLC. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.
- C. The isolator module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
- D. Isolator modules shall have integral mounting brackets, and be capable of being mounted in a 5-inch square, 2.125-inch deep electrical box or surface-mounted backbox. Screw terminals shall be provided for connections to the SLC and the device(s) being monitored.

2.11 NOTIFICATION APPLIANCES

- A. Combination Audible/Visual Notification Appliances:
 - 1. The audible portion of the combination audible/visual notification appliances shall be 24 VDC polarized, electronic horns. Rated reverberant output of the appliance shall be not less than 82 dBA



at 10 feet when measured in accordance with UL 464 at nominal input voltage. Housings shall be white with red "FIRE" lettering.

2. The visual indicating portion of such combination appliances shall be 24 VDC polarized xenon tube stroboscopic devices, with minimum effective intensity not less than 15 candela per UL 1971 and a near-axis intensity of not less than 75 candela (light intensity not less than 117 candela per UL 1638 for exterior devices), light source color clear or nominal white, flash rate not less than 1 Hz nor more than 3 Hz, integrally mounted on the audible device. These appliances shall be compatible with, and capable of being connected in a Style Z (Class A) synchronization scheme.
- B. Visual-only notification appliances shall be 24 VDC polarized xenon tube stroboscopic devices, with minimum effective intensity not less than 15 candela per UL 1971 and a near-axis intensity of not less than 75 candela (light intensity not less than 117 candela per UL 1638 for exterior devices), light source color clear or nominal white, flash rate not less than 1 Hz nor more than 3 Hz, of the same manufacturer as the combination audible/visual notification appliances. These appliances shall be compatible with, and capable of being connected in a Style Z (Class A) synchronization scheme. Housings shall be white with red "FIRE" lettering.
- C. Building location strobe lights shall be UL Listed for outdoor use, 24 VDC polarized devices, xenon tube, with red lens, flashing rate not to exceed 2 Hz. Light output shall be UL Listed for not less than 8.0 candela/seconds.
 1. Location Lights: Amseco, Model SL-524R, or equal (no known equal).

2.12 VISUAL ANNUNCIATOR

- A. The annunciator shall be exterior, weatherproof, tamperproof, with a hinged door. It shall be of one of the following two styles:
 1. Red cottage style construction, with a keyed lock, provided with weatherproof "bullseye" annunciator indicating lamps and holders with clear or white lenses of not less than 0.6875 inches in diameter. Lamps shall be 24 or 28 VDC, 3.0 minimum spherical candlepower, 0.170 amp rated current, 250 hours minimum rated life, red-colored (No. 313R or equal). The annunciator shall have a lamp for each required zone (see 3.2.7) plus a minimum of 10 percent (but not less than four) spare indicating lights. Wiring shall terminate on terminal blocks. Where control panel zones are to be combined to a reduced number for the annunciator, provide diode matrix at FACP to accomplish. Exterior finish shall be suitable for coastal environment.
 2. An analog display having a separate lamp or LED for each required zone (see 3.2.7) plus a minimum of 10 percent (but not less than four) spare lamps or LEDs, installed within a NEMA 4X enclosure provided with a window cover of sufficient size to permit observation of the entire display. The front of the enclosure shall either be hinged and provided with a lock keyed as per 2.15, hinged and secured with screws, or have a front entirely secured with screws. Remote annunciators which require operation of controls to see alarms on multiple zones are not acceptable.
- B. Lamp power for the annunciator shall be supplied by separate power supply with FACP-monitored power-on supervision. This supply shall be independent of FACP ground-fault supervision. Power supply, including charging circuitry and batteries, shall meet the requirements specified for FACP power supplies.
- C. Legends for annunciators as per 2.11.1.1 shall be permanently-engraved 0.125-inch minimum thickness plastic laminate—red in color with black lettering. Lettering shall be san-serif block style, all uppercase, 0.375-inch high minimum. Attach legends using double-sided tape with tamper-resistant screws at each corner.
 1. During construction, the contractor shall ensure that the system supplier/designer coordinate requirements with the CALIFORNIA STATE Fire Marshal to provide a system fully-compliant with this specification.

2.13 FIRE ALARM TERMINAL CABINETS AND TERMINALS

- A. The main fire alarm terminal cabinet shall have a minimum depth of 6 inches; all others shall have a minimum of 4-inch depth. All shall have full-face doors with integral, permanently-attached hinges and integral locks; have 0.75-inch deep fire retardant treated plywood (or integral formed steel) backboards;



and be sized to allow neat wire and terminal installation. The main FATC shall be of such a size to leave a minimum clear backboard space 8 inches wide by 18 inches high at one side after installation of terminal strips, wiring, and any other devices/equipment.

1. Exception: Auxiliary FATCS (FATCS other than the main FATC or floor FATCS, containing modules and/or terminal blocks) in locations not readily accessible to the public (e.g., above ceilings, in locked electrical or mechanical rooms, above 8 feet a.f.f., etc.) Need only be provided with a positive means of latching.
- B. Terminal blocks to be pressure plate box type, 300 volt medium duty, rated for No. 22 through No. 10 solid and stranded wire, polypropylene, dovetail base, tubular clamp, mounted on prepunched aluminum channel: Buchanan P0625 Terminals with P0630 end sections, No. 68 clamps, and No. 67 channel, or equal (no known equal).

2.14 BATTERIES

- A. Batteries shall be rated for the capacity to operate the system in a full supervisory mode with AC power removed for 24 hours followed by operation of all notification appliances for 5 minutes. Batteries shall be lead-calcium, sealed, maintenance-free type.
1. The calculations done to determine the size batteries necessary to meet this requirement should be accomplished in accordance with the recommendations of the battery manufacturer with regard to the effects of applying a high-current load after a long period of low-current load. Regardless of the method used for the calculations, and/or the battery size(s) shown on approved shop drawings, the system contractor is responsible for providing batteries with the capacity required to successfully demonstrate compliance with this requirement.
 2. The above requirements apply equally to any batteries associated with supplementary and/or auxiliary power supplies determined necessary to fully power the system, as well as to the annunciator power supply.

2.15 BATTERY CABINETS

- A. Each battery cabinet shall be a separate, locking cabinet manufactured for the purpose.

2.16 CABINET LOCKS

- A. Cabinet locks, including FACP's, battery cabinets, FATCs, and annunciators shall be keyed to the College standard.
1. Exception: auxiliary FATCS (FATCS other than the main FATC or floor FATCS, containing modules and/or terminal blocks) in locations not readily accessible to the public (e.g., above ceilings, in normally-locked electrical or mechanical rooms, above 8 feet a.f.f., etc.) need only be provided with a positive means of latching.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install equipment in compliance with manufacturer's written recommendations and installation instructions.
- B. Locate and install conduit, devices, equipment, and accessories as specified. FACP's shall be located in approved electrical rooms.
1. Mount FACP's, FATCs, and any other control equipment such that terminals are located between 42 and 66 inches above the adjacent walking surface.
 2. Center manual pull stations 48 inches above finished floor.
 3. Install backboxes for all notification appliances with the bottom 80 inches above finished floor, or 10 inches below finished ceiling, whichever is lower.
 4. Install backboxes for remote alarm LED/test stations and remote alarm LEDs with the bottom 80 inches above finished floor. Install on the strike side of the door of the room/space within which a smoke, heat, or duct smoke detector is located. If, for any reason, the remote alarm LED/test station cannot be mounted on the wall immediately adjacent to the door, provide a durable printed label on the remote alarm LED/test station identifying the room number of that room.



5. Install visual annunciators at a height of 54 to 60 inches from finished grade to bottom of housing, adjacent to fire access lanes, as shown on the drawings. If pedestal-mounted, provide an engraved legend firmly attached to the pedestal with tamper proof screws. Specific locations to be approved by the CALIFORNIA STATE Fire Marshal and the College's Representative.
 6. The main FATC shall be located immediately adjacent to the FACP. The underground conduit for CAMPUS Fire Alarm Monitoring Station connection shall be extended to this cabinet.
 7. There shall be no cabinets or equipment installed below a battery cabinet.
 8. All conduit, devices, and equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place. Smoke detectors shall not be supported solely by suspended ceilings. Fasteners and supports shall be adequate to support the required load.
 9. All equipment and devices installed in exterior or other locations exposed to the outside environment shall be approved and UL Listed for such application, or shall be installed in a NEMA 4X enclosure. All conduit, fittings and hardware shall be corrosion resistant rigid type.
 10. All modules (e.g., monitor modules, control modules, signal modules, and isolator modules) shall be installed within an FATC, mounted in an appropriately-sized backbox.
 11. Exception: Miniature monitor modules may be installed within interior or weatherproof exterior manual fire alarm station backboxes.
 12. Equipment installed in flammable or explosive atmospheres shall be approved and UL Listed for such application. All raceway and fittings shall be installed in accordance with the California Electrical Code for hazardous (classified) locations.
 13. Provide a lockdown clip for each circuit breaker supplying power to system components. Circuit breakers shall be permanently and clearly identified at the circuit breaker panel by red marking and shall be identified as "FIRE ALARM CIRCUIT." Additionally, the location and designation of the circuit breaker panel, and the circuit breaker number(s) shall be permanently and clearly identified at the powered system component.
 14. Door holders shall hold door open until smoke has been detected by the smoke detector(s) provided. When actuated, the device shall release door to close and shall release automatically on power failure. Door holding devices shall NOT be connected to battery supply.
 15. Building location strobe lights shall be located on the exterior of the building so as to be visible from the fire access lanes, as determined by the CALIFORNIA STATE Fire Marshal. They shall be securely mounted atop a section of rigid conduit so as to be 4 feet above the roof edge at the specified location, unless otherwise noted on the drawings or directed by the CALIFORNIA STATE Fire Marshal. They shall be powered by an independent notification appliance circuit and shall operate continuously when the FACP is in an alarm condition.
 16. Penetrations of fire-rated construction shall be firestopped using an approved, listed through-penetration firestop system as specified in Division 7 Section "Firestopping."
 17. Auxiliary power required by any device shall be 24 VDC, provided and supervised by the FACP in such a manner as to be identified separately from any other trouble condition.
 18. FACP batteries shall be installed in battery cabinets as per 2.14.
 19. Weatherproof manual stations shall be installed as surface-mounted devices, attached to the wall by screws through the pre-cast holes in the backbox only; no additional holes may be drilled. If entry into the box is from the rear, using the knockout provided, the foam gasket provided with the manual station must be used. Regardless of whether entry is through the top, bottom, or rear, it must be by conduit.
 20. Exception: when the rear knockout is used for entry, conduit may terminate at a single-gang outlet box, with the weatherproof backbox then installed using screws through the pre-cast holes. A knockout bushing is required.
- C. System wiring shall conform to the following requirements:
1. All wire shall be new.
 2. Minimum wire size shall be No. 12 AWG (No. 14 AWG permitted for IDC and NAC wiring not exceeding 25 VDC; No. 18 AWG permitted for SLC wiring), type THWN, 600 volt, solid copper. Wire



- size shall be increased as required to maintain voltage and current capacity. Voltage drop shall not exceed manufacturer's listing for NACs, but shall in no case exceed 10 percent.
3. Spare conductors shall be provided on a 10 percent (minimum two conductor) schedule per riser; annunciator panels shall be wired for full capacity, plus a minimum of six (6) spare conductors.
 4. All system circuits (including, but not limited to initiating device, notification appliance, signaling line, power, and relay circuits) shall be run above-grade and/or overhead (i.e., there shall be no system circuit wiring in or below floor slabs).
 5. Exception: visual annunciator circuit wiring and post indicator valve tamper switch circuit wiring.
 6. Wiring shall be continuous from FATCs to other FATCs, field devices and to the FACP. Splicing (whether in terminal boxes, junction boxes, device boxes, or below-grade) shall not be permitted. Parallel branches ("T" taps) are not permitted regardless of the method of supervision employed.
 7. Exception: devices available only with "pig-tail" connections shall be connected to the circuit wiring using approved insulated wire nuts.
 8. Only those wires directly serving a duct detector shall be routed through its housing.
- D. Terminal cabinets shall be provided and configured to conform to the following requirements:
1. All field wiring and FACP wiring shall be terminated in FATCs or on field devices.
 2. There shall be at least one FATC for each floor (the main FATC may serve as the floor FATC for the floor on which it is located).
 3. All system wiring shall be terminated in the main FATC. In addition, the wiring for each floor shall be terminated in that floor's FATC prior to entering and returning from the field.
 4. All connections shall be made on terminals. There shall be one electrically independent terminal block segment for each conductor.
 5. Circuit completions shall be accomplished with cross-connect jumper wires, 2 inches to 3 inches long, between pairs of vertically-oriented terminal blocks. All field device wiring shall terminate on the right-hand terminal strip; FACP wiring shall terminate on the left-hand terminal strip.
 6. Exception: in an FATC other than the main FATC or a floor FATC, the second terminal block and cross-connect jumpers may be omitted.
 7. Terminal blocks shall be permanently identified with a sequential numbering scheme. All wires (with the exception of cross-connect jumpers) shall be identified with their corresponding terminal blocks with substantial markers.
 8. There shall be 10 percent spare sets of terminals, minimum of 12 sets, installed in each main and floor FATC.
 9. A minimum clear backboard space 8 inches wide by 18 inches high at one side shall be provided in the main FATC after installation of terminal strips, wiring, and any other devices/equipment.
 10. All relays and other components carrying 120 VAC (e.g., for door holder circuits) shall be in separate FATCs from those containing the low-voltage system circuitry and/or components.
 11. Exception: such components may be installed within system FATCS if installed in separate enclosures labeled "caution--120 VAC" within them, with all 120 VAC wiring in conduit within the system FATC.
 12. Terminal cabinets shall be hinged on the side farther from the FACP.
- E. Conduit shall be provided and configured to conform to the following requirements:
1. All wiring shall be in metal conduit, concealed in interior locations, except that Schedule 40 PVC conduit shall be used underground. Minimum conduit size shall be 0.75-inch. EMT conduit shall be used in all above-ground locations, except that rigid steel conduit (PVC-coated where indicated below) shall be used in the following locations:
 2. Where required by code.
 3. In electrical, mechanical, and machine rooms.
 4. Where exposed to weather (PVC-coated).
 5. Where exposed and below 7 feet 6 inches above finished floor.
 - a. Exception: Occupied or finished spaces.
 6. Where in slabs or in concrete (PVC-coated).



7. Where exposed to physical damage.
 8. In corrosive areas (PVC-coated).
 9. In damp or wet locations (PVC-coated).
 10. All system wiring shall be installed in conduit independent of all other electrical circuits.
 11. All styles of Class A circuits (initiating device, signaling line, and notification appliance circuits) shall be wired without parallel branches, with return conductors separate (i.e., in separate conduit) from outgoing conductors, and are to start at and return to the main FATC. Conduit containing outgoing conductors shall be physically separated from conduit containing return conductors by not less than 12 inches horizontally; there is no separation requirement for vertical conduit.
 12. Conduit containing outgoing conductors and conduit containing return conductors separated by a wall of not less than one-hour fire-resistive construction may be spaced closer.
 13. Outgoing and return conductors may be routed through the same conduit for a distance of not more than 10 feet to an initiating device, notification appliance, or control panel enclosure.
 14. Initiating device circuits and signaling line circuits shall be installed in separate conduit from notification appliance circuits. No circuit shall pass through a device mounting box, J-box, pull-box, or any other component of any other circuit.
 15. Exception: for risers connecting floor FATC's, initiating device circuits, signaling line circuits, and notification appliance circuits may be installed in the same conduit.
 16. Maximum conduit fill shall be 75 percent of that permitted by the California Electrical Code.
 17. All system conduit shall be red color. All junction box covers shall be externally identified by permanent red paint suitable for the purpose.
 18. Conduit containing auxiliary circuit wiring as defined in 1.2.2 are not to be so identified.
 19. Magnetic door holding circuits and other non-power limited circuits shall be in separate raceway.
 20. Exposed flexible conduit, as used for attachment to waterflow and valve tamper switches or similar applications, shall be liquid-tight and shall be the minimum length required for neat and secure installation. Flexible conduit lengths shall not exceed 3 feet. Flexible conduit shall not be buried nor located closer than 12 inches to grade.
 21. Conduit shall be arranged such that only those wires directly serving a duct detector are routed through its housing.
 22. Conduit shall not penetrate shaft walls nor be routed within shafts unless serving system components located within the shaft. Where a system component is located within a shaft, wiring to it shall be by means of a single conduit as permitted by Exception.
- F. Signaling Line Circuits (SLCs) and initiating devices shall be installed to comply with NFPA 72 and the following requirements:
1. Smoke detector quantity and spacing shall be as recommended by the manufacturer and NFPA. Smoke detectors shall not be located in a direct airflow nor closer than 3 feet from an air supply diffuser.
 2. Install manual stations in 4S deep boxes with single-gang rings whenever miniature monitor modules will be contained within the box.
 3. Exception: manual stations as per 2.3.3 shall be surface-mounted, with wiring entering the supplied backbox via conduit into the provided threaded knock-out only. The backbox shall be secured via screws through the through-holes provided; no additional penetrations of the backbox shall be made.
 4. Provide wiring and connections to devices (such as, but not limited to: fire sprinkler waterflow switches, valve tamper switches, and waterflow alarm bells; duct smoke detectors; electrically-actuated smoke dampers; and roll-down fire door releasing devices) installed by other work.
 5. Duct smoke detectors for closure of smoke/fire dampers shall be installed in accordance with manufacturer's installation instructions, within 5 feet of the smoke/fire damper, on the duct on the same side of the floor or wall as the smoke/fire damper actuator. Install duct detectors on the vertical sides of horizontal ducts only. Any required auxiliary power shall be 24 VDC provided and supervised by the FACP in such a manner as to be identified separately from any other trouble condition.



6. Exception: with advance approval from the CALIFORNIA STATE Fire Marshal, duct smoke detectors may be installed on the duct on the opposite side of the wall or floor from the smoke/fire damper actuator.
 7. Smoke or heat detectors located within concealed spaces (e.g., duct detectors located above the ceiling, in interstitial spaces, etc.) or in other areas not readily accessible (e.g., installed on roof-mounted air handling equipment, above 8 feet A.F.F., etc.) shall be provided with readily-accessible remote alarm LED/test stations located as per 3.1.1.4 in an approved location. Smoke or heat detectors located within rooms/spaces shall be provided with readily-visible remote alarm LED located as per 3.1.1.4 in an approved location.
 8. Remote alarm led/test stations connected to duct detectors for closure of smoke/fire dampers in corridor walls required to be of fire-resistive construction shall be installed in the corridor, regardless of which side of the wall the detector is actually located on.
 9. Duct smoke detectors shall be installed in accordance with the manufacturer's written installation instructions, especially those portions having to do with required air differential pressure (see 3.6.12). Detectors failing the air pressure differential testing shall be relocated as necessary to permit passing the test.
- G. Notification Alarm Circuits (NACs) and notification appliances shall be installed to comply with NFPA 72 and the following requirements:
1. The total of all audible/visual notification appliances on each circuit shall consume no more than 75 percent of the available output current of the notification appliance circuit module to which they are connected. The aggregate current demand of all audible/visual notification appliances shall not exceed 75 percent of the system power supply available for audible/visual devices.
 2. Provide notification appliances in electrical and mechanical equipment rooms.
 3. The System Contractor shall determine the number and location of audible notification appliances necessary to meet the audibility requirements which shall be included in the submittals. Any audible notification appliances shown on the drawings shall be considered as sample locations only and shall be supplemented as required to meet audibility requirements. Tests shall be made to prove that audible notification appliances meet these requirements; additional audible notification appliances required as a result of this test shall be provided and installed without cost to the College.
 4. Audible notification appliances shall be selected and located to provide a minimum sound level of 15 dBA above ambient in all areas and shall be rated for a minimum of 82 dBA at 10 feet on axis with a maximum of 100 dBA. There shall be audible notification appliance installed on each floor within each apartment unit and in similar dwelling units.
 5. Audible notification appliances shall be semi-flush mounted in accordance with their listing.
 6. Every audible notification appliance shall be provided with a visual notification appliance mounted on the audible notification appliance housing. In addition, there shall be a visual notification appliance installed in every sleeping room.
 7. The visual notification appliances shown on the drawings shall be considered as sample locations only and shall be supplemented to meet requirements of NFPA 72, 1999, as amended by Part 2, Title 24, California Code of Regulations. If additional visual notification appliances are required to meet these requirements, they shall be provided and installed without cost to the College.
 8. An addressable control module shall be provided to supervise and control the operation of each auxiliary notification appliance power supply used in the system.
 9. Audible/visual notification appliance power shall be provided by a separate supervised power loop from the main FACP or from a supervised, UL Listed remote power supply.

3.2 GENERAL SYSTEM OPERATION

- A. Basic Performance:
1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto a Style 6 (Class A) signaling line circuit equipped with isolator modules as specified herein.
 2. Initiation device circuits shall be Style D (Class A).
 3. Notification appliance circuits shall be Style Z (Class A).



4. Digitized electronic signals shall employ check digits or multiple polling.
5. A single ground or open on the signaling line circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
6. Alarm signals arriving at the FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.
7. The system shall be zoned, by use of isolator modules, in accordance with the following:
 8. By building.
 9. By floor.
 10. By wing or fire area.
 11. At both ends of every underground circuit.
 12. There shall be a minimum of 10 percent spare capacity for additional devices between each pair of isolators/isolation modules.
 13. Resetting of all devices shall be a single operation accomplished at the FACP.
 14. Silencing of an alarm shall not prevent subsequent initiating devices from initiating and indicating an alarm in a non-interfering manner.
 15. During construction, the contractor shall ensure that the system supplier/designer coordinate requirements with the CALIFORNIA STATE Fire Marshal to provide a system fully-compliant with this specification.
- B. The system shall be installed and wired with all necessary equipment, wiring, conduit, and hardware to perform all designated functions. Activation of any alarm initiating device shall result in, as a minimum, the following:
 1. The System (Fire) Alarm LED shall flash.
 2. A local piezo-electric signal in the control panel shall sound.
 3. The 80-character LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
 4. Activate all notification appliances throughout the building. In buildings so equipped, activate all voice alarm systems as per 3.2.11. Unless otherwise approved in advance by the CALIFORNIA STATE Fire Marshal, all audible notification appliances and all visual notification appliances throughout the building shall be synchronized.
 5. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.
 6. Cause annunciation by zone at the visual annunciator.
 7. Transmit an alarm condition to the CAMPUS Fire Alarm Monitoring Station.
 8. Continue the alarm condition until manually reset.
 9. Release all door holders in the building.
 10. Operate building location strobe/annunciator lights (provided with non-coded power) until manually reset (not silenceable).
 11. All alarms originating from smoke detectors (including duct detectors) shall undergo alarm verification (maximum delay: 60 seconds) prior to initiating a general alarm condition.
- C. Activation of any system trouble or supervisory condition shall be indicated audibly and visually at the FACP and shall transmit a trouble signal to the CAMPUS Fire Alarm Monitoring Station.
- D. Activation of a duct smoke detector for closure of a smoke/fire damper shall initiate the closure of the associated damper, as well as initiating an alarm at the FACP.
- E. The visual annunciator shall provide visual indication of an alarm condition of, at a minimum, the following initiating devices:
 1. Manual Stations: By floor, wing and fire zone.
 2. Smoke and Heat Detectors: By floor, wing, and fire zone.
 3. Duct Smoke Detectors: By floor, wing, and fire zone.
 4. Sprinkler Waterflow: By floor, wing, and fire zone.



- 5. Special System Monitoring: By system (e.g., Halon, Inergen, dry chemical, carbon dioxide).
- F. Operation of the SIGNAL (ALARM) SILENCE switch at the FACP shall deactivate all notification appliances (both audible and visual, except for the building location strobe light[s]). Activation of any other alarm initiating device shall cause them to be reactivated.
- G. Activation of a smoke or heat detector with an associated remote alarm LED shall result in illumination of the alarm LED.

3.3 IDENTIFICATION

- A. Provide identification of equipment and materials.

3.4 GROUNDING

- A. All metallic conduit, cabinets, junction boxes, and exposed non-current-carrying metal parts shall be permanently grounded. A separate No. 10 AWG conductor shall connect a grounding bus bar located in the main FATC to building ground. The bus bar shall be provided with a minimum of five tubular, pressure type screw terminals sized for No. 18 AWG through No. 10 AWG wire. The ground wire for the FACP and the main FATC shall be grounded via the bus bar.

3.5 DOCUMENTATION

- A. Copies of complete as-built installation wiring documentation, internal FACP schematics, and maintenance manuals are to be submitted prior to final acceptance.

3.6 SYSTEM ACCEPTANCE TESTING

- A. Prior to acceptance testing of the system, it shall be tested and adjusted by the contractor under the supervision of a factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.
- B. When the system is complete and operating normally in all respects, the Contractor shall furnish necessary equipment and personnel to perform acceptance testing, as described herein. Acceptance testing shall be accomplished in the presence of the CALIFORNIA STATE Fire Marshal and the Owner's Representative, and at the direction of the CALIFORNIA STATE Fire Marshal. The purpose of the testing is to ensure that all equipment and devices are installed in an approved manner and are performing as specified. Any deficiencies found must be rectified and the system retested.
 - 1. The system contractor shall provide not less than two persons, at least one of whom shall have been personally involved in the installation of the system, and at least one of whom shall have been personally involved in the programming/start-up of the system. In addition, the system contractor shall provide not less than three units of two-way communication equipment capable of communicating between any two points within the building. Finally, the system contractor shall have available for, and to be retained by the CALIFORNIA STATE Fire Marshal a preliminary set of as-built drawings, and at least one copy of the operation manual for the FACP.
- C. Testing will include, but not be limited to, the following:
 - 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
 - 2. Close each sprinkler system control valve and verify proper supervisory alarm at the FACP.
 - 3. Verify activation of all flow switches.
 - 4. Open initiating device circuits and verify that the trouble signal actuates.
 - 5. Open and short signaling line circuits and verify that the trouble signal actuates.
 - 6. Open and short notification appliance circuits and verify that trouble signal actuates.
 - 7. Ground all circuits and verify response of trouble signals.
 - 8. Check presence and audibility of all notification appliances.
 - 9. Check installation, supervision, and operation of all intelligent smoke detectors.
 - 10. Each of the alarm conditions that the system is required to detect shall be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.



11. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, alarm verification functionality and similar.
12. With the air handling unit turned on, and all filters and dampers in place, measure the air differential pressure on all duct smoke detectors which use sampling tubes.
13. Verify zones annunciated on the visual annunciator agree with the initiating zone.
14. When any defects are detected, make repairs or install replacement components, and repeat the tests as required.
15. When all other tests have been completed to the satisfaction of the College's Representative, the system shall be continuously operated on battery power for a period not less than 24 hours, immediately followed by a period not less than 5 minutes during which all notification appliances shall operate continuously. The test shall be considered to have been successfully accomplished if all notification appliances operate as specified throughout the 5-minute period.

3.7 DEMONSTRATION AND TRAINING

- A. The Contractor shall provide the services of a system manufacturer's trained and authorized engineer/technician for providing instruction and training to College's personnel in the operation, maintenance and repair of the complete system. The instruction and training shall be held at the College's premises or at an authorized training facility in two sessions of 8 hours each, and shall be provided at no additional cost to the College. "Hands-on" demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.
- B. A typewritten "Sequence of Operation" shall be provided.

END OF SECTION 28 31 11



**SECTION 31 10 00
SITE CLEARING**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Clearing and protection of vegetation.
- B. Removal of existing debris.

1.2 RELATED REQUIREMENTS

- A. Section 01 56 39 – Tree and Plant Protection
- B. Section 01 74 19 – Construction Waste Management and Disposal
- C. Section 03 30 00 – Cast-in-Place Concrete
- D. Section 03 33 10 – Landscape Site Concrete Walls
- E. Section 12 93 00 – Site Furnishings
- F. Section 31 22 00 – Grading: Topsoil removal.
- G. Section 31 23 16 – Excavation
- H. Section 31 23 23 – Fill: Fill material for filling voids and excavations generated as a result of site clearing and demolition operations.
- I. Section 32 12 16 – Asphalt Paving
- J. Section 32 12 17 – Decomposed Granite Paving
- K. Section 32 13 13 – Concrete Paving
- L. Section 32 13 16 – Decorative Concrete Paving
- M. Section 32 14 13 – Unit Paving
- N. Section 32 84 00 – Landscape Irrigation
- O. Section 32 93 13 – Lawns and Grasses
- P. Section 32 93 16 – Exterior Plants
- Q. Section 33 41 11 – Storm Drainage Utility Piping

1.3 REFERENCE STANDARDS

- A. Standard Specifications for Public Works Construction (“Green Book”), current edition

1.4 SUBMITTALS

- A. Water Pollution Control Best Management Practices: As required by contract documents and permit conditions.
- B. Site Plan indicating:
 - 1. Vegetation removal limits.
 - 2. Areas for temporary construction laydown/storage, field offices and contractor parking.

1.5 QUALITY ASSURANCE

- A. Clearing and Site Demolition: Contractor experienced in the type of work required and with the proper equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Fill Material: Furnish and place fill material as approved by geotechnical engineer.



PART 3 - EXECUTION

3.1 SITE CLEARING

- A. Providing construction surveying to establish limits of site demolition.
- B. Install water pollution control and dust control measures as first order of work.
- C. Minimize dust generation due to clearing operations through watering or other approved measures.

3.2 EXISTING UTILITIES AND BUILT ELEMENTS

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Request and coordinate DigAlert for public/franchise utility markout. Provide private mark-out service for private utilities not covered by DigAlert and perform potholing to confirm locations of existing utilities.
- C. Protect existing utilities to remain from damage.
- D. Clearly mark and protect existing structures, utilities and other elements that are not to be removed.

3.3 VEGETATION

- A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.
- B. Do not begin clearing until vegetation to be relocated has been removed.
- C. Do not remove or damage vegetation beyond the limits indicated on drawings.
 - 1. 10 feet outside the building perimeter or site limits as indicated.
- D. Install orange construction fence at least 3 feet high to prevent inadvertent damage to MiraCosta College vegetation to remain:
 - 1. At vegetation removal limits.
 - 2. Around trees and other vegetation to remain within vegetation removal limits; locate no closer to tree than at the drip line.
- E. In areas where vegetation must be removed but no construction will occur other than previous paving, remove vegetation with minimum disturbance of the subsoil.
- F. Vegetation Removed: Do not burn, bury, or leave removed vegetation on site.
 - 1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
 - 2. Trees: Remove stumps and roots to depth of 24 inches.
 - 3. Existing Stumps: Remove stumps and roots to depth of 24 inches.
 - 4. Fill holes left by removal of stumps and roots, using approved fill material, with top surface neat in appearance and matching existing grade.
- G. Dead Wood: Remove all dead trees (standing or down), limbs, and dry brush on entire site; treat as specified for vegetation removed.
- H. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

3.4 DEBRIS

- A. Recycle construction waste in accordance with construction waste management requirements.
- B. Remove debris, deleterious material and trash from site.
- C. Leave site in clean condition, ready for subsequent work.
- D. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 31 10 00



**SECTION 31 22 00
GRADING**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Removal and storage of topsoil.
- B. Rough grading the site for site structures and building pads.
- C. Replacement of topsoil and finish grading.

1.2 RELATED REQUIREMENTS

- A. Section 01 56 39 - Tree and Plant Protection
- B. Section 01 74 19 – Construction Waste Management and Disposal
- C. Section 31 10 00 - Site Clearing
- D. Section 31 23 16 – Excavation
- E. Section 31 23 23 - Fill
- F. Section 32 12 16 – Asphalt Paving
- G. Section 32 12 17 – Decomposed Granite Paving
- H. Section 32 13 13 – Concrete Paving
- I. Section 32 13 16 - Decorative Concrete Paving

1.3 PRICE AND PAYMENT PROCEDURES

- A. Earthwork:
 - 1. Measurement Method: By the cubicyard, in place.
 - 2. Includes, but not limited to: Excavating existing topsoil, stockpiling and placing where required and compacting.

1.4 SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with Standard Specifications for Public Works Construction, current edition.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Topsoil: See Section 31 23 23.
- B. Topsoil: Topsoil excavated on-site.
 - 1. Graded.
 - 2. Free of roots, rocks or clumps larger than 4 inches, subsoil, debris and deleterious material.
- C. Other Fill Materials: See Section 31 23 23.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that survey bench mark and intended elevations for the Work are as indicated in field.

3.2 PREPARATION

- A. Perform construction surveying to locate required lines, elevations, and datum.
- B. Stake and flag locations of known utilities. Pothole to verify locations.
- C. Locate, identify, and protect from damage overhead and underground utilities to remain.



- D. Notify utility company(ies) in advance to remove and/or relocate existing utilities.
- E. Protect site features to remain, including but not limited to, bench marks, existing structures, fences, sidewalks, utilities, paving, and curbs from damage by construction operations.
- F. Protect trees to remain by providing temporary construction fencing around entire tree at the outer tips of its branches; no grading is to be performed inside this line.
- G. Protect plants and other features to remain as part of final landscaping.

3.3 ROUGH GRADING

- A. Remove and stockpile topsoil as indicated.
- B. Remove and dispose of unsuitable soils as directed by geotechnical engineer.
- C. See Section 31 23 23 for filling procedures.
- D. Benching Slopes: Horizontally bench existing slopes greater than 1:4 as directed by geotechnical engineer.
- E. Remedial Grading: Remove and recompact soils and perform other remedial grading as directed by geotechnical engineer.
- F. Excavate material and place fill to line and grade as indicated.

3.4 SOIL REMOVAL AND STOCKPILING

- A. Stockpile excavated topsoil on site, and re-use as indicated.
- B. Remove excess from site.
- C. Stockpiles: Use areas designated on site; pile depth not to exceed 6 feet; protect from erosion by covering with plastic sheeting.

3.5 FINISH GRADING

- A. Before Finish Grading:
 - 1. Verify building and trench backfilling have been inspected.
 - 2. Verify pavement subgrade has been contoured and compacted to 95% R.C.
- B. Remove debris, roots, branches, stones, in excess of 4 inches in size. Remove soil contaminated with petroleum products.
- C. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 12 inches.
- D. Place topsoil in areas indicated.
- E. Place topsoil where required to level finish grade.
- F. Remove roots, weeds, rocks, and foreign material while spreading.
- G. Near buildings spread topsoil manually to prevent damage.
- H. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
- I. Lightly compact placed topsoil.

3.6 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 0.10 foot from required elevation.

3.7 REPAIR AND RESTORATION

- A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.
- B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds.
- C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.



3.8 FIELD QUALITY CONTROL

- A. See Section 31 23 23 for compaction density testing.

3.9 CLEANING

- A. Remove unused stockpiled topsoil. Grade stockpile area to prevent standing water.
- B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION 31 22 00



**SECTION 31 23 16
EXCAVATION**

PART 1 - GENERAL

1.1 NOT USED

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities that remain and protect from damage.

3.2 EXCAVATING

- A. Excavate to accommodate new structures and construction operations.
- B. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- C. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- D. Do not interfere with 45 degree influence line of foundations.
- E. Cut utility trenches wide enough to allow inspection of installed utilities.
- F. Hand trim excavations. Remove loose matter.
- G. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 31 23 23.
- H. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- I. Remove excavated material that is unsuitable for re-use from site.
- J. Remove excess excavated material from site.

END OF SECTION 31 23 16



**SECTION 31 23 23
FILL**

PART 1 - GENERAL

1.1 NOT USED

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Identify required lines, levels, contours, and datum locations.

3.2 PREPARATION

- A. Scarify subgrade surface to a depth of 6 inches to identify soft spots.
- B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with approved fill.
- C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.3 FILLING

- A. Fill to contours and elevations indicated using unfrozen materials.
- B. Employ a placement method that does not disturb or damage other work.
- C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- D. Maintain optimum moisture content of fill materials to attain required compaction density.
- E. Slope grade away from building minimum 2%, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- F. Correct areas that are over-excavated.
 - 1. Other areas: Use general fill, flush to required elevation, compacted to minimum 90 percent of maximum dry density.
- G. Compaction Density Unless Otherwise Specified or Indicated: 90% min., 95% in upper 12 inches of pavement subgrades.
- H. Reshape and re-compact fills subjected to vehicular traffic.

3.4 FIELD QUALITY CONTROL

- A. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("modified Proctor").
- B. If tests indicate work does not meet specified requirements, remove work, replace and retest.

END OF SECTION 31 23 23



SECTION 32 11 23
AGGREGATE BASE COURSES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Aggregate base course.
- B. Paving aggregates.

1.2 RELATED REQUIREMENTS

- A. Section 32 12 16 - Asphalt Paving: Finish and binder asphalt courses.
- B. Section 32 13 13 - Concrete Paving: Finish concrete surface course.

1.3 REFERENCE STANDARDS

- A. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18 in.) Drop 2021.
- B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)) 2012 (Reapproved 2021).
- C. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method 2015, with Editorial Revision (2016).
- D. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)) 2012 (Reapproved 2021).
- E. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method 2015.
- F. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) 2017, with Editorial Revision (2020).
- G. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) 2017a, with Editorial Revision.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. When aggregate materials need to be stored on site, locate where directed by Owner.
- C. Aggregate Storage, General:
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Coarse Aggregate: Coarse aggregate, conforming to State of California Public Works Department standard.
- B. Medium Aggregate: Natural stone; pea gravel, washed, free of clay, shale, organic matter.
- C. Fine Aggregate: Sand; conforming to State of California Public Works Department standard.
- D. Herbicide: United States EPA-registered chemical herbicide suitable for application indicated.
 - 1. Manufacturer: Provide products complying with requirements of the contract documents and made by one of the following:
 - a. Ciba-Geigy Corporation.
 - b. DowElanco.
 - c. E. I. du Pont de Nemours and Company, Inc.

2.2 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for general requirements for testing and analysis of aggregate materials.
- B. Where aggregate materials are specified using ASTM D2487 classification, test and analyze samples for compliance before delivery to site.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.
- B. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.2 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place aggregate on soft, muddy, or frozen surfaces.

3.3 INSTALLATION

- A. Under Bituminous Concrete Paving:
 - 1. Compact to 95 percent of maximum dry density.
- B. Under Portland Cement Concrete Paving:
 - 1. Compact to 95 percent of maximum dry density.
- C. Place aggregate in maximum 4 inch (100 mm) layers and roller compact to specified density.
- D. Level and contour surfaces to elevations and gradients indicated.
- E. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.
- F. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
- G. Use mechanical tamping equipment in areas inaccessible to compaction equipment.
- H. Apply herbicide to finished surface.

3.4 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch (6.4 mm) measured with 10 foot (3 m) straight edge.
- B. Scheduled Compacted Thickness: Within 1/4 inch (6.4 mm).
- C. Variation From Design Elevation: Within 1/2 inch (12.8 mm).

3.5 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for general requirements for field inspection and testing.
- B. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
- C. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with AASHTO T 180, ASTM D698 ("standard Proctor"), or ASTM D1557 ("modified Proctor").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.

3.6 CLEANING

- A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION 32 11 23

**SECTION 32 12 16
ASPHALT PAVING**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Aggregate base course.
- B. Single course bituminous concrete paving.
- C. Surface sealer.

1.2 RELATED REQUIREMENTS

- A. Section 32 11 23 - Aggregate Base Courses: Aggregate base course.
- B. Section 32 13 13 - Concrete Paving: Concrete substrate.

1.3 REFERENCE STANDARDS

- A. AI MS-2 - Asphalt Mix Design Methods 2015.
- B. AI MS-19 - Basic Asphalt Emulsion Manual 2008.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with State of California Public Work's standard.
- B. Mixing Plant: Conform to State of California Public Work's standard.
- C. Obtain materials from same source throughout.

1.5 FIELD CONDITIONS

- A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F (4 degrees C), or surface is wet or frozen.
- B. Place bitumen mixture when temperature is not more than 15 F degrees (8 C degrees) below bitumen supplier's bill of lading and not more than maximum specified temperature.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aggregate for Base Course: In accordance with State of California Public Work's standards.
- B. Aggregate for Binder Course: In accordance with State of California Public Work's standards.
- C. Aggregate for Wearing Course: In accordance with State of California Public Work's standards.
- D. Fine Aggregate: In accordance with State of California Public Work's standards.
- E. Mineral Filler: Finely ground particles of limestone, hydrated lime or other mineral dust, free of foreign matter.
- F. Primer: In accordance with State of California Public Work's standards.
- G. Tack Coat: Homogeneous, medium curing, liquid asphalt.
- H. Seal Coat: AI MS-19, sand type.
- I. Wood Headers, Stakes, Benders and Splices: "Foundation" grade redwood as graded by Redwood Inspection Service. Minimum 2" thick lumber for headers and stakes and minimum 1" thick boards for splices. Use galvanized nails for fastening.

2.2 ASPHALT PAVING MIXES AND MIX DESIGN

- A. Asphalt Base Course: 3.0 to 6 percent of asphalt cement by weight in mixture in accordance with AI MS-2.
- B. Binder Course: State of California Public Work's standards.
- C. Submit proposed mix design of each class of mix for review prior to beginning of work.

- D. Asphalt Concrete:
1. Top course in playground areas: PWC Specifications, Section 203-6, Class E-AR 4000. Rolled thickness shall be 1".
 2. Parking areas, driveways and first course of playground areas: PWC Specifications, Section 203-6, Class C1-AR 4000. Rolled thickness in parking areas and driveway shall be as shown on the plans. Rolled thickness of first course in playground areas shall be specified thickness as shown on plans minus the 1" top course.

2.3 SOURCE QUALITY CONTROL

- A. Test mix design and samples in accordance with AI MS-2.

PART 3 - EXECUTION

3.1 GENERAL

- A. Comply with cross sections, elevations, and grades indicated on the drawings.
- B. Prepare and install pavement structures in accordance with practices recommended in the "Asphalt Paving Manual"; Publication MS-8; Asphalt Institute, except to the extent that such practices are superseded by specific requirements of this section.

3.2 EXAMINATION

- A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.
- C. Notify architect in writing of any unsatisfactory conditions. Do not begin paving installation until these conditions have been satisfactorily corrected.
- D. Commencement of paving work shall constitute acceptance of subbase conditions.

3.3 PREPARATION

- A. General: Immediately before placing asphalt concrete mix, remove all loose or deleterious material from surface over which pavement will be placed. Ensure that subbase is properly prepared to receive paving.
1. Aggregate subbase:
 - a. Sweep loose granular particles from surface of aggregate course. Do not dislodge or disturb in any way the aggregate embedded in compacted surface of subbase course.
 - b. Proof roll prepared sub-base surface to check for unstable areas and areas requiring additional compaction. Repair these areas as required. Do not begin paving work until deficient sub-base areas have been corrected and are ready to receive paving.
- B. General Surface Applications to Prepared Subbase:
1. Herbicide application over subbase:
 - a. Apply herbicide treatment over dry compacted subbase, adhering strictly to herbicide manufacturer's instructions.
 - b. Take extreme precaution to confine weed killer to only those areas to be covered by asphalt concrete and provide all necessary protection to prevent injury or damage to life and property.
 2. Prime coat application over aggregate subbase:
 - a. Schedule prime coat application sufficiently in advance of placement of paving mix to allow thorough setting.
 - b. Apply prime coat at a rate of 0.20 to 0.50 gallon per square yard. Do not flood surface, but apply sufficient quantity to penetrate and seal.
 - c. Cure for period required to allow adequate penetration, as well as evaporation of volatiles.
 - d. If asphalt is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use just enough sand to prevent pickup under traffic. After volatiles have evaporated, remove loose sand by sweeping before overlaying pavement is placed.
 - e. Take suitable precautions to protect coated subbase from damage until it is in proper condition to receive paving.

3.4 INSTALLATION

A. Techniques:

1. Placing the mix:
 - a. Spread mix at minimum temperature of 225 degrees F.
 - b. Place asphalt concrete mix on prepared surface and strike off. Place inaccessible and small areas using hand tools.
 - 1) Check mat frequently during placement, to verify correct thickness.
 - c. Before rolling operations begin, check surface using template and straightedge, and correct irregularities.
 - d. Width of paving strips:
 - 1) Place mix in paving strips at least 10 feet wide.
 - 2) Roll first paving strip after placement. Place subsequent paving strips, extending rolling operation to overlap preceding strips.
 - e. Coursing requirements:
 - 1) Lifts:
 - a) Base Course:
 - b) Place plant-mixed asphalt concrete base course in single lift.
 - c) Compact to 95 percent.
 - d) Moisture Content: Use only the amount of moisture needed to achieve the specified compaction.
2. Joints:
 - a. General: Construct joints to form continuous bond between adjoining portions of work. Ensure that texture and density of pavement are continuous across the joint. Surface across joint shall form smooth, uninterrupted plane and shall not pond water.
 - b. Joint locations include the following:
 - 1) Between pavements laid on successive days.
 - 2) At any point in paving where material already laid has become cold because of delay.
 - c. Clean by brushing, or cut fresh vertical face using power saw if necessary, wherever contact surface of previously constructed pavement has become coated by dust, sand, or other objectionable material.
 - d. Apply thin tack coat on vertical contact surface before beginning placement of new material.
3. Rolling:
 - a. Start rolling operation as soon as hot mix will bear weight of roller and can be compacted without unacceptable displacement of material.
 - b. Comply with roller manufacturer's recommended rolling speed, but in no case exceed 3 miles per hour.
 - c. Avoid sharp turns and abrupt starts and stops.
 - d. Compact mixture in areas inaccessible to rollers using hot hand tampers or vibrating plate compactors.
 - e. Breakdown rolling:
 - 1) If grade is not absolutely level, begin breakdown rolling on low side of spread. Progress toward high side.
 - 2) Execute initial breakdown pass with drive wheel forward toward the direction of paving.
 - 3) Examine surface immediately after breakdown rolling. Repair as necessary by loosening material in defective areas and filling with hot material.
 - f. Second (intermediate) rolling:
 - 1) Execute second rolling as soon as possible after breakdown rolling, while mixture is still hot enough to achieve maximum density.
 - 2) Continue repeating the pattern until mixture has been compacted thoroughly.
 - g. Finish rolling:
 - 1) Execute finish rolling while mixture is sufficiently warm to allow removal of roller marks.

- 2) Continue rolling operation until maximum density is achieved and roller marks are entirely eradicated.
 4. Asphalt Concrete Curbs:
 - a. Construct curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust.
 - b. Place curb material to cross-section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms as soon as material has cooled.
 5. Patching:
 - a. Remove paved areas which are contaminated with foreign materials or which are defective in any way. Replace removed material with fresh, hot mix. Compact by rolling until maximum density and smoothness are achieved and there is no detectable variation between patch and adjacent paving.
 - b. Patch or re-pave area as required as a result of reconstruction or adjusting manholes, cleanouts, vaults, grates, etc. to proper grade.
 6. Restriction of traffic:
 - a. Upon completion of rolling operations, do not permit vehicular traffic on pavement until it has cooled and hardened sufficiently.
 - b. Erect clearly-visible barricades and take other measures as required to protect pavement.
 7. Wood Headers:
 - a. Install along all edges of asphalt concrete paving except where concrete paving, walks and curbs occur. Set top edge of header to conform to grade of asphalt paving. Benders of lesser thickness may be used to form returns.
 - b. Space stakes not exceed 4' on centers, unless otherwise noted. Drive stakes to a depth of 1" below the top of the header and nail to headers.
 - c. Splice joints between individual header boards with a 1" thick board same height as header and not less than 24" long.
- B. Interface with Other Products:
1. Pavement marking:
 - a. Do not begin application of pavement-marking paint until architect has approved marking placement.
 - 1) Verify proper placement of each color of marking paint.
 - b. Sweep and clean pavement surface thoroughly, immediately before application of marking paint. Pavement shall be dry and in proper condition to receive paint.
 - c. Use mechanical paint applicator to create pavement marks with consistently even edges. Apply 2 coats at paint manufacturer's recommended spreading rates.
 - d. Layout play courts to exact requirements of owner. Verify layout line widths and color prior to painting.

3.5 AGGREGATE BASE COURSE

- A. Place and compact aggregate base course.
- B. Spread to uniform thickness; water and roll until firm enough to support material trucks without displacement or rutting.
- C. Compacted thickness (unless noted otherwise on civil drawings):
 1. Type A Areas: 6".
 2. Type B Areas: 9".
 3. Type C Areas: 4".

3.6 PREPARATION - PRIMER

- A. Apply primer in accordance with manufacturer's instructions.
- B. Apply primer on aggregate base or subbase at uniform rate of 1/3 gal/sq yd (1.5 L/sq m).
- C. Use clean sand to blot excess primer.

3.7 PREPARATION - TACK COAT

- A. Apply tack coat in accordance with manufacturer's instructions.
- B. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of 1/3 gal/sq yd (1.5 L/sq m).

3.8 PLACING ASPHALT PAVEMENT - SINGLE COURSE

- A. Install Work in accordance with State of California Public Work's standards.
- B. Place asphalt within 24 hours of applying primer or tack coat.
- C. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- D. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.9 SEAL COAT

- A. Apply seal coat to asphalt surface course and asphalt curbs in accordance with AI MS-19.
- B. Preparation:
 - 1. Clean paving surface removing all loose, foreign materials.
 - 2. Remove existing concrete parking bumpers prior to seal coat application and replace all bumpers on the original manner after curing period.
 - 3. Preventative measures shall be taken to protect existing concrete surfaces including curbs, walks, light pole bases, etc. from over splash by seal coat.
- C. Parking Areas, Driveways, Walkways and Ramps: Apply slurry seal coat to surface course and asphalt curbs in accordance with AI MS-19. Emulsion shall be applied uniformly over entire area, and extreme care must be exercised so there will be no spots with excess material which would remain tacky.
 - 1. Application:
 - a. Per manufacturer's recommendations.
 - b. Protect adjacent surfaces from mixture.
 - c. Apply evenly in two coats. Spread immediately with rubber faced squeegees; pull at angle from line of spread, to roll material toward operator. After each coat has dried, remove ridges with scraper.
 - d. Total Application Rate for Two Coats: Apply at an undiluted rate of 0.2 gallons minimum per square yard. Increase application rate due to porosity per manufacturer's written recommendations.
 - 2. Protect from traffic for three (3) days minimum after application.

3.10 TOLERANCES

- A. Installation Tolerances:
 - 1. Maximum allowable variance of in-place compacted thickness from design thickness -- base course: Plus 1/2 inch, minus zero inches.
 - 2. Maximum allowable variance of surface smoothness - base course: Plus or minus 1/4 inch.
 - a. Use 10-foot straightedge moved systematically over entire paved area to determine compliance with surface smoothness tolerance indicated.
 - 3. In-place density: Pavement shall be compacted to at least 96 percent of density obtained by laboratory compaction.

3.11 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for quality control.
- B. Provide field inspection and testing. Take samples and perform tests in accordance with AI MS-2.
- C. General: Test in-place asphalt concrete courses for compliance with requirements for thickness, surface smoothness and density. Repair or remove and replace unacceptable paving as directed by Architect.
- D. Thickness: In-place compacted thickness will not be acceptable if exceeding following allowable variation from required thickness.



1. Base Course: Specified thickness minus 1/2".
 2. Surface Course: Specified thickness plus or minus 1/4".
- E. Surface Smoothness: Test unfinished surface of each asphalt concrete course for smoothness, using 10' straight edge applied parallel with, and at right angles to centerline of paved area. Surface will not be acceptable if exceeding the following tolerances for smoothness.
1. Base Course Surface: 1/4".
 2. Wearing Course Surface: 1/8".
- F. Flood Test: Prior to application of seal coats, perform a flood test in the presence of the Owner's representative.
1. Method:
 - a. Flood the entire asphalt concrete paved areas with water by use of a tank truck or hoses.
 - b. If a depression occurs, where water ponds to a depth of more than 1/8", fill or otherwise correct to provide proper drainage.
 - c. Feather and smooth the edges of fill so that the joint between fill and original surface is invisible.
- G. Densities:
1. Density of the asphalt concrete after rolling shall be 95 percent of the density obtained with the California Kneading Compactor per California Test 304.
 - a. Density of the aggregate base course shall be 95 percent of maximum relative density.

3.12 PROTECTION

- A. Immediately after placement, protect pavement from mechanical injury for 7 days or until surface temperature is less than 140 degrees F (60 degrees C).

END OF SECTION 32 1216



**SECTION 32 12 17
DECOMPOSED GRANITE PAVING**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. All services, labor, materials, transportation, tools and equipment necessary to perform the work indicated on the Drawings including the installation of base material and header edging.

1.2 REFERENCES

- A. The edition of the specifications and standards referenced herein, published by the following organization, apply to the granular paving work only to the extent specified in the drawings and specifications.
- B. Standard Specifications for Public Works Construction, 2000 Edition including Regional Supplements Amendments.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Conform to procedures and quantities as specified under Section 01 33 00.
 - 2. For base course, submit material Certification and Analysis Report.
 - 3. Decomposed Granite: Provide packaged sample equal to one half (1/2) pound, include source of material with telephone number and address.
 - 4. Aggregate Binder: Provide packaged samples equal to one half (1/2) pound, include manufacturer's instructions for mixing and application.
 - 5. Decomposed Granite and Binder Compound: Provide a packaged sample, pre-blended in proportions recommended by the manufacturer, and equal to one (1) pound.

1.4 QUALITY ASSURANCE

- A. Use skilled workmen trained and experienced in the necessary crafts, and who are completely familiar with the requirements and the methods needed for proper performance of the work of this Section.

1.5 MOCK-UPS

- A. Construct at earliest possible time and at approved location before proceeding with the work.
 - 1. Prepare one (1) 10 feet by width of path, paving mock-up, complete with compacted subgrade, edging, and compacted as specified. Include adjustments, approved by the College's Representative from reviews of the mock-up process. Coordinate work with conditions and material placement of other work and adjacent conditions.
 - 2. The Mock-up shall be reviewed and approved by the College's Representative prior to proceeding with the work. When necessary, remove and reconstruct the field sample until approved. Approved mock-up shall serve as the standard of acceptance for the paving work.
 - 3. The approved mock-up may be incorporated into the final work. Demolish and remove non-approved mock-ups.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Pre-blended Material: Deliver material in sealed containers that are clearly labeled with the name, weight, batch number, and supplier.
- C. Bulk Material: Comply with Section 01 60 00 for delivery and storage requirements.
- D. Do not expose materials to moisture or other conditions that would adversely affect their serviceability.
- E. Store materials out of the weather and off the ground.



PART 2 - PRODUCTS

2.1 MATERIALS

- A. Decomposed Granite (DG): Paving material shall be crushed stone, maximum 3/8" minus with fines from granite source rock. Color "TBD" available from Decorative Stone Solutions 1- 800-699-1878, or approved equal.
- B. Binder Component: Shall be Stabilizer™ available from Decorative Stone Solutions 1- 800-699-1878, no known equal.
- C. Water, clean potable.
- D. Steel Edge Restraints: Corten steel edge 1/8" x 6" depth with steel angle tabs welded 36" O.C and drilled to receive # 4 rebar stakes, install per detail and as indicated on drawings.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Areas receiving paving materials shall be examined for correct and complete base preparation, compaction, grade, pitch, and drainage installation.
- B. Prepared subgrade shall be proof rolled to check for unstable conditions and areas requiring additional compaction. The subgrade shall be compacted to a minimum 95% dry density. A compaction test shall be taken at questionable areas identified by the College's Representative.
- C. Report unsatisfactory conditions to the College's Representative. Do not begin paving work until unsatisfactory conditions have been corrected and is ready to receive paving. Proceeding with the installation constitutes acceptance of existing conditions and responsibility for satisfactory performance.
- D. Herbicide Treatment: Pre-emergence herbicide shall be recommended and applied by a licensed pest control service. Apply herbicide in strict compliance with manufacturer's recommended instructions, and local and state regulations. Apply to compacted, dry, subgrade prior to application of aggregate base course. Do not use weed control chemicals that may stain decomposed granite or surrounding surfaces.

3.2 PREPARATION

- A. The base for the paving shall be compacted native sub-grade, refer to geotechnical report.
- B. The binding agent shall be mixed at the rate of 13 pounds per ton (2000 pounds) of decomposed granite.
- C. Whether pre-mixed or mixed on site, the decomposed granite and binding agent shall be thoroughly blended and tumbled in a cement mixer or pug mill at the rate specified.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's written instructions.
- B. Apply quantity to achieve depth indicated on the Drawings. Areas shall be raked and graded to achieve a smooth finished surface after rolling.
- C. Areas shall be thoroughly watered to the full depth of the paving material.
- D. Rolling of the mixture shall commence once thorough moisture penetration is completed. The paving areas shall be compacted with a small riding roller or power walk-behind roller. Pneumatic compactors are not permitted. Corners and areas not accessible to the roller shall be hand tamped to match the compaction of the adjacent area. The finished surface shall be smooth and consistent across the entire area, free of ruts, dips, humps, and roller marks.
- E. Provide a sufficient quantity of grade stakes as to provide decomposed granite paving with smooth finish grade and positive drainage.
- F. Steel Headers: Verify that steel headers have been installed in solid subgrade and are at the correct elevation and horizontal alignment. Install straight sections free of wiggles using string lines as guides.



Install curved sections as smooth curves free of wiggles following alignment as indicated on drawings and as accepted by College's representative in the field.

- G. At the end of the day, the installation shall terminate at a paving edge or other transition. No material shall be deposited on paving which has hardened sufficiently to cause the formation of seams, planes, weakness within the section, or visible lines in the finished surface.

3.4 PROTECTION

- A. Protect the entire area from foot or vehicular traffic until fully dried. Protect the area from contamination or damage by other work in progress.

3.5 MAINTENANCE

- A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
- B. Patch and or replace areas damaged during the construction period. Remove weeds by hand, rake smooth, moisten and re-compact to a smooth finished surface. Do not use weed control chemicals that may stain the decomposed granite or other surface materials.

END OF SECTION 32 12 17

**SECTION 32 13 13
CONCRETE PAVING**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Concrete sidewalks.

1.2 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading: Preparation of site for paving and base and preparation of subsoil at pavement perimeter for planting.
- B. Section 32 11 23 - Aggregate Base Courses: Aggregate base course.
- C. Section 32 17 26 - Tactile Warning Surfacing: Plastic tactile and detectable warning tiles for pedestrian walking surfaces.

1.3 REFERENCE STANDARDS

- A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete 1991 (Reapproved 2009).
- B. ACI 301 - Specifications for Concrete Construction 2020.
- C. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete 2000 (Reapproved 2009).
- D. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2020.
- E. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2018a.
- F. ASTM C33/C33M - Standard Specification for Concrete Aggregates 2018.
- G. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens 2021.
- H. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete 2021b.
- I. ASTM C150/C150M - Standard Specification for Portland Cement 2021.
- J. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method 2016.
- K. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete 2019.
- L. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete 2019.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on joint filler, admixtures, and curing compound.
- C. Design Data: Indicate pavement thickness, designed concrete strength, reinforcement, and typical details.

1.5 CODE REQUIREMENTS

- A. Portland cement concrete paving & concrete finishes:
 - 1. Portland cement concrete paving shall be stable, firm, and slip resistant and shall comply with CBC Sections 11B-302 and 11B-403.



PART 2 - PRODUCTS

2.1 PAVING ASSEMBLIES

- A. Concrete Sidewalks and Median Barrier: 3,000 psi (20.7 MPa) 28 day concrete, 4 inches (100 mm) thick, buff color Portland cement, exposed aggregate finish.

2.2 FORM MATERIALS

- A. Wood form material, profiled to suit conditions.

2.3 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi) (420 MPa) yield strength; deformed billet steel bars; unfinished.
- B. Steel Welded Wire Reinforcement: Plain type, ASTM A1064/A1064M; in flat sheets; unfinished.
- C. Dowels: ASTM A615/A615M, Grade 40 - 40,000 psi (280 MPa) yield strength; deformed billet steel bars; unfinished finish.

2.4 CONCRETE MATERIALS

- A. Obtain cementitious materials from same source throughout.
- B. Cement: ASTM C150/C150M, Normal - Type I Portland cement, gray color.
- C. Fine and Coarse Mix Aggregates: ASTM C33/C33M.
- D. Fly Ash: ASTM C618, Class C or F.
- E. Water: Clean, and not detrimental to concrete.

2.5 ACCESSORIES

- A. Curing Compound: ASTM C309, Type 1, Class A.
- B. Tactile Warning Surfaces: See Section 32 1726.

2.6 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
 - 1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.
- D. Concrete Properties:
 - 1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; 4,000 psi.
 - 2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
 - 3. Water-Cement Ratio: Maximum 45 percent by weight.
 - 4. Total Air Content: 4 percent, determined in accordance with ASTM C173/C173M.
 - 5. Maximum Slump: 4 inches (100 mm).

2.7 MIXING

- A. Transit Mixers: Comply with ASTM C94/C94M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.2 SUBBASE

- A. See Section 32 1123 for construction of base course for work of this Section.

3.3 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.

3.4 FORMING

- A. Place and secure forms to correct location, dimension, profile, and gradient.
- B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.5 REINFORCEMENT

- A. Place reinforcement at midheight of slabs-on-grade.
- B. Interrupt reinforcement at contraction joints.
- C. Place dowels to achieve pavement and curb alignment as detailed.

3.6 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Ensure reinforcement, inserts, embedded parts, formed joints and [] are not disturbed during concrete placement.
- C. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
- D. Apply surface retarder to all exposed surfaces in accordance with manufacturer's instructions.

3.7 JOINTS

- A. Align curb, gutter, and sidewalk joints.
- B. Place 3/8 inch (10 mm) wide expansion joints at 20 foot (6 m) intervals and to separate paving from vertical surfaces and other components and in pattern indicated.
 - 1. Form joints with joint filler extending from bottom of pavement to within 1/2 inch (13 mm) of finished surface.
 - 2. Secure to resist movement by wet concrete.
- C. Provide scored joints.
 - 1. At 5 feet ([] m) intervals.
 - 2. Between sidewalks and curbs.
 - 3. Between curbs and pavement.
- D. Saw cut contraction joints 3/16 inch (5 mm) wide at an optimum time after finishing. Cut 1/3 into depth of slab.

3.8 FINISHING

- A. Sidewalk Paving (Up to 5% Slope): Medium broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius.
- B. Curbs and Gutters: Light broom, texture parallel to pavement direction.
- C. Inclined Ramps (5% Slope or more): Heavy Broomed perpendicular to slope.
- D. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.9 TOLERANCES

- A. Maximum Variation of Surface Flatness: 1/4 inch (6 mm) in 10 ft (3 m).
- B. Maximum Variation From True Position: 1/4 inch (6 mm).

3.10 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 4000 - Quality Requirements.



1. Provide free access to concrete operations at project site and cooperate with appointed firm.
 2. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
 3. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.
- B. Compressive Strength Tests: ASTM C39/C39M; for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd (76 cu m) or less of each class of concrete placed.
1. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
 2. Perform one slump test for each set of test cylinders taken.
- C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.11 CONCRETE CURING

- A. Comply with requirements of ACI 308. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Moist cure and maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
1. Normal concrete: Not less than 5 days.
- C. Surfaces Not in Contact with Forms:
1. Start initial curing as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
 2. Begin final curing after initial curing but before surface is dry.
- D. Curing compound: Apply in two coats at right angles, using application rate recommended by manufacturer.

3.12 PROTECTION

- A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.
- B. Do not permit pedestrian traffic over pavement for 7 days minimum after finishing.

END OF SECTION 32 13 13



**SECTION 32 13 16
DECORATIVE CONCRETE PAVEMENT**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Furnishing of services, labor, materials, transportation, tools and equipment necessary to perform the work indicated on the Drawings and specified herein as required to properly complete the work in this contract.
- B. This Section includes the following:
 - 1. Cement concrete pavement Landscape Site Concrete Paving
- C. Related Sections include the following: List below only products and construction that the reader might expect to find in this Section but are specified elsewhere.
 - 1. 01 56 39 - Tree and Plant Protection
 - 2. 03 30 00 - Cast-in-place Concrete
 - 3. 03 33 10 - Landscape Site Concrete Walls
 - 4. 12 93 00 - Site Furnishings
 - 5. 31 10 00 - Site Clearing
 - 6. 31 22 00 - Grading
 - 7. 31 23 16 - Excavation
 - 8. 31 23 23 - Fill: Compacted Subbase for Paving
 - 9. 32 12 17 - Decomposed Granite Paving
 - 10. 32 13 13 - Concrete Paving
 - 11. 32 14 13 - Unit Paving
 - 12. 32 84 00 - Landscape Irrigation
 - 13. 32 93 13 - Lawns and Grasses
 - 14. 32 93 16 - Exterior Plants
 - 15. 33 41 11 - Storm Utility Drainage Piping

1.2 REFERENCES

- A. Conform to the following codes and standards:
 - 1. American Institute (ACI)
 - 2. American Society" for Testing and Materials (ASTM): The specifications and standards hereinafter referred.
 - 3. Standard Specifications for Public Works Construction 2000

1.3 DEFINITIONS

- A. Definition in this Article refers to those materials that make up cementitious component of water-cementitious materials ratio.
- B. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

- A. Product Data: Furnish manufacturer's product specifications and installation instructions for the following and for each type of product indicated.
 - 1. Integral color/ color admixture
 - 2. Form release agent
 - 3. Plastic dowel sleeves
 - 4. Curing agents
 - 5. Clear sealer
 - 6. Expansion joint filler material
 - 7. Fiber reinforcement
 - 8. Joint sealant



9. Finish retardant
- B. Products; Submit one-pound samples, clearly identified, for each component used to prepare each paving type, including but not limited to:
 1. Aggregate
- C. Design Mixtures: Furnish certified reports of proposed mix design for each type of concrete installation. For each decorative cement concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- D. Paving Mix Designs: Provide documentation for each paving type specified on Drawings that will enable College's Authorized Representative's to better match replaced concrete:
- E. Laboratory and Cement Test Reports: Submit six (6) copies of laboratory test reports for concrete materials and a certificate with each concrete mixer truck, stating mix design, PSI, rating, slump, water and cement quantity, cement/water ration, fine and coarse aggregate and color additives.
 1. Cement:
 - a. Manufacturer and plant location.
 - b. Cement type, i.e. Type I, II, III, or V.
 2. Admixtures:
 - a. Manufacturer and plant location.
 3. Sand:
 - a. Source and Type.
 4. Aggregates:
 - a. Source and Type.
 5. Sign certification from a licensed structural engineer.
- F. Coordinate paragraph below with qualification requirements in Division 1 Section "Quality Control" and as supplemented in "Quality Assurance" Article.
 1. Qualification Data: For Installer.
 - a. Installer: Provide evidence to indicate successful experience in providing decorative concrete work similar to that specified herein and can demonstrate successful experience through past Project documentation and references.
 - b. Experience: Minimum 5 years' experience in the installation of patterned concrete paving.
 - c. Demonstration of Experience: 10 Projects which have been completed within the past 36 months utilizing similar products, scope and complexity.
 - d. Supervision: Perform placement and finishing of concrete work under supervision of a person having a minimum of 5 years of experience in placement and finishing of products specified herein.
 2. Submit qualifications to College's Authorized Representative for information purposes. Submit a resume of Project Manager and Superintendent who will be overseeing the Work.
- G. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:
 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
 2. Material Certificates: For the following materials, signed by manufacturers:
 - a. Cementitious materials.
 - b. Steel reinforcement and reinforcement accessories.
 - c. Fiber reinforcement.
 - d. Admixtures.
 - e. Curing compounds.
 - f. Applied finish materials.
 - g. Bonding agent or epoxy adhesive.



- h. Joint fillers.
- 3. Field quality-control test reports.
- 4. Minutes of pre-installation conference.
- 5. Delivery slips.
- H. Certification that College's Authorized Representative's sample panels have been reviewed and that materials and processes provided will achieve intended effects indicated on College's Authorized Representative's sample panel.
- I. Submittals for above items shall be made in one package. If submittals are judged incomplete or non-responsive to the directions of the College's Representative after three (3) submissions the Contractor shall be back charged for the College's Representatives costs to process additional Submittals. Additional Submittal Procedures are specified in Section 01300.

1.5 QUALITY ASSURANCE

- A. Delete first paragraph below if requirements in Division 1 Section "Quality Control" are sufficient. Verify that selected manufacturers provide training and approval. Revise if installers are qualified by other means.
- B. Installer Qualifications: An employer of workers trained and approved by manufacturer of decorative cement concrete pavement systems.
- C. Pre-Bid Conference: Prior to submitting bid, attend pre-bid conference with College's Authorized Representative to review College's Authorized Representative's production run quality samples of all specified concrete colors and finishes and to review requirements and artistic effect desired.
- D. Slip Resistance: Provide a finish surface slip resistance coefficient of friction equal or greater than 0.6 for flat surfaces and 0.8 for ramps, when tested in accordance with ASTM F 489.
- E. Ready-Mix-Concrete Producer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Producer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- F. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
- G. Source Limitations: Obtain decorative cement concrete pavement products and each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate through one source.
- H. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.
- I. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- J. Referee Panels: The College's Representative will provide production run quality samples of all specified concrete paving colors and finishes to be used as Referee Panels to judge the Field Mock-ups. The College's Representative will provide information and assist the Contractor on the mix design components used to achieve the Referee Panels.
- K. Mockups: Cast mockups of sections approximately 48-inches by 48-inches of decorative cement concrete pavement to demonstrate typical pattern, texture, surface finish, color, joints, and standard of workmanship.
 - 1. Build mockups in the location and of the size indicated or, if not indicated, as directed by College's Representative. Include joints and joint materials, caulking, and scoring treatments specified on the plans.



2. If multiple colors and finishes are specified, all samples shall be prepared for review at the same time.
 3. In presence of College's Representative, damage part of the exposed surface of decorative cement concrete pavement for each finish, color, and texture required, and demonstrate materials and techniques proposed for repair to match adjacent undamaged surfaces.
 4. The Mock-ups shall be reviewed and approved by the College's Representative before proceeding with the work. Mock-ups will be judged against the appearance of the Referee Panels. Mock-ups that do not match the Referee Panels and do not demonstrate all specified joints and joint materials, caulking, and scoring treatments will be rejected. Remove and reconstruct the mock-ups until approved. The Contractor shall be back charged for the costs of the College's Representative to review more than two (2) mock-up attempts. Approved mock-ups shall serve as standard of acceptance for paving work and remain available for the duration of the project.
 5. Demolish and remove mock-ups at the completion of the project.
- L. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings" and Quality Control."
1. Before submitting design mixtures, review decorative cement concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and decorative cement concrete pavement construction practices. Require representatives of each entity directly concerned with decorative cement concrete pavement to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixes.
 - c. Ready-mix concrete producer.
 - d. Decorative cement concrete pavement Installer.
 2. Manufacturer's representative of decorative cement concrete pavement system.
- M. Formwork: Comply with Recommended Practice for Concrete Formwork, ACI 347.
1. Qualifications: Refer to Section 01400 Quality Requirements.

1.6 PROJECT CONDITIONS

- A. Delete this Article if not required.
- B. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

1.7 DELIVERY AND HANDLING

- A. Conform to Section 01600 Product Requirements.
- B. Deliver, store, and handle reinforcement to prevent damage.

1.8 REGULATORY REQUIREMENTS

- A. Testing: Slump tests shall be taken to certify compliance with mix design. Slump shall be in accordance
- B. Mix design shall be in accordance with ACI 211-6. with ASTM C 143.
- C. Conform to applicable laws, codes, and regulations required by authorities having jurisdiction over the work.

1.9 SITE CONDITIONS

- A. Do not place concrete when subbase surface temperature is less than 40 degrees F, nor when surface is wet.

1.10 COORDINATION

- A. In accordance with Section 01315.
- B. Ensure that irrigation sleeves, electrical conduit, and other utility elements are accommodated and as-built located prior to pouring concrete.

1.11 INSPECTION OF SITE

- A. Verify conditions at site affect Work of this Section and take field measurements as requires. Report major discrepancies between Drawings and field dimensions to College's Authorized Representative prior to commencing work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. Products: Subject to compliance with requirements, provide one of the products specified.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORMS

- A. Form Materials: Either steel or wood, of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use forms that are free of distortion and defects.
- B. Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 - 1. Use flexible or curved forms for curves of a radius 100 feet or less.
 - 2. Flexible spring steel forms, laminated boards, or bender boards to form radius bends as required.
- C. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration indicated. Provide solid backing and form supports to ensure stability of textured form liners.
 - 1. Form work to be new, #2 grade Douglas Fir, free of knots, checks, bows, and cracks.
 - 2. Form-Release Agent: A non-staining form release compound that will not discolor or deface the surface of the concrete. Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
 - 1. Grade 40 or 60 billet steel conforming to ASTM A 626/615M. Bending process shall conform to the Manual of Standard Practice of the Concrete Reinforcing Steel Institute. Kinked bars shall not be used.
 - 2. Reinforcement Bars #3 @ 18 inch OC each way or #4 @ 15 inch OC each way or as required by structural and/or Geotechnical Report.
 - 3. Reinforcing Steel: Conforming to ASTM A 615, clean and free of rust, dirt, grease or oils.
- B. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.
- C. Plain Steel Wire: ASTM A 82, as drawn.
- D. Plastic-surfaced or reinforced-paper-covered dowels are available from proprietary sources.
- E. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.
- F. Plastic dowel alignment sleeves Products:
 - 1. Speed Dowel or equal (no known equal).
- G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:



- H. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
- I. Polypropylene Fiber Reinforcement: 100% virgin multifilament polypropylene fibers, engineered and designed for secondary reinforcement of concrete slabs, complying with ASTM C 1116 - Type III.
 - 1. Acceptable Manufacturers:
 - a. Fibermix®; Stealth® Fibers – 1/4" long (423)892-8080 or www.fibermesh.com.
 - b. Forta Fiber; Microfiber (800)245-0306.
 - c. Grace Construction Products; Microfiber™ (800)433-0020 or www.grace.com.
 - 2. Application Rate: 1/2 lb./cy of mix.

2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use one of the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Gray Portland Cement: ASTM C 150, Type II
- B. Refer to Drawings for specific paving finishes requiring different cement types, to include Type II cements (unless otherwise identified in the Drawings) conforming to ASTM C 150.
- C. Use same brand of cement from single source throughout entire Project for each paving type.
- D. Refer to Statement of Mix Design for cement type used.
- E. Fly Ash: ASTM C 618, Class F.
- F. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- G. Select class of aggregate from options in first paragraph below or revise to suit Project. ASTM C 33 limits deleterious substances in coarse aggregate depending on climate severity and in-service location of concrete. Classes 4S, 4M, and 1N apply to pavements in Severe, Moderate, and Negligible weathering regions, respectively. Retain last option if damage caused by concrete expansion from alkali silica or alkali carbonate reactions is anticipated.
- H. Normal-Weight Aggregates: ASTM C 33, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar pavement applications and service conditions using similar aggregates and cementitious materials.
- I. Select coarse-aggregate size from options in subparagraph below, adding gradation requirements if preferred. Larger aggregate is not recommended for stamped concrete. Verify that aggregate size selected is appropriate for patterns and textures selected for stamped concrete.
- J. Maximum Aggregate Size: Refer to Drawings for maximum aggregate size. Coarse Aggregate: Aggregate composed of gravel, crushed rock, or a blended mixture conforming to Standard Specifications Section 200-1.4. Aggregates shall be washed clean, uniformly screen graded, and contain no more than 2% by weight of deleterious materials such as shale, schist, alkali, clay lumps, earth loam, mica, or similar materials.
- K. Clean, hard, and durable coarse aggregate, conforming to ASTM C 33.
- L. Use same coarse aggregate from single source throughout entire Project.
- M. Refer to Statement of Mix Design for coarse aggregate type used.
- N. Aggregates shall be washed clean, uniformly screen graded, and contain not more than 2% by weight of deleterious materials such as shale, schist, alkali, clay lumps, earth loam, mica, or similar materials.
- O. Delete subparagraph below unless retaining this optional ASTM C 33 requirement.
- P. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
 - 1. Sand shall consist of a natural or manufactured granular material, or combination thereof, free of deleterious amounts of organic material, mica, loam, clay and other substances not suitable for the purpose intended. Sand shall be washed and conform to Standard Specifications Section 200-1.5.3.
- Q. Clean, hard, and durable washed concrete sand, conforming to ASTM C 33.



- R. Use same fine aggregate from single source throughout the entire Project.
- S. Refer to Statement of Mix Design for fine aggregate type used.
- T. Sand shall be free of deleterious amounts of organic material, mica, loam, clay and other substances not suitable for the purpose intended.
- U. Base Material: Washed concrete sand, uniformly graded and meeting the requirements of Standard Specifications Section 200-2.2. At the time of spreading, the material shall have a moisture content sufficient to obtain the required compaction.
- V. Structural Soil Base: Structural "CU" soil base material available through Hanson Aggregates (refer to specification section 02520. Refer to drawings for extend of concrete paving on structural soil.
- W. Water: Potable and complying with ASTM C 94/C 94M. Free from deleterious materials such as oils, acids, and organic matter.
- X. Air-Entraining Admixture: ASTM C 260.
- Y. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 3. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.

2.5 ADMIXTURES

- A. Provide concrete admixtures that contain not more than 1 percent chloride ions and no calcium chloride.
- B. Water-Reducing Admixture: ASTM C 494, Type A.
- C. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G.
- D. Water-Reducing and Retarding Admixture: ASTM C 494, Type D or E.
- E. Acceptable Manufacturers:
 - 1. Water-Reducing Admixtures:
 - a. ChemMasters Corp; Chemtard.
 - b. Cormix Construction Chemicals: Type A Series.
 - c. Euclid Chemical Company; Eucon WR-75.
 - 2. High-Range Water-reducing Admixtures:
 - a. Anti-Hydro Co. Inc.: super P.
 - b. Cormix Construction Chemicals: Cormix 2000, PSI Super.
 - c. Euclid Chemical Company; Eucon 37.
 - 3. Water-Reducing and Acceleration Admixtures:
 - a. Conspec Marketing & Manufacturing Company; Q-Set.
 - b. Cormix Construction Chemicals; Gilco Accelerator or Lub NCR.
 - c. Euclid Chemical Company; Lithochrome Surface Retarder.

2.6 COLOR MATERIALS

- A. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
- B. Integral Color: Integrally color concrete in colors, blending mixtures and application rates necessary to create colors, gradations, and variations to match College's Authorized Representative's mock-up.
- C. Manufacturers:
 - 1. Davis Colors.
 - 2. Solomon Colors.



2.7 CURING MATERIALS

- A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per square yard, complying with AASHTO M 182, Class 2.
- B. Moisture-Retaining Cover: One of the following complying with ASTM C 171:
 - 1. Waterproofing paper.
 - 2. Polyethylene film.
 - 3. White burlap-polyethylene sheeting.
- C. Clear, Waterborne Membrane-Forming Curing Compounds:
 - 1. Provide curing materials that have a maximum volatile organic compound (VOC) rating of 350 g/l.
- D. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
 - 1. Clear, Waterborne Membrane-Forming Curing Compounds Acceptable Manufacturers:
 - a. Anti-Hydro Company; Clear Cure Water Base.
 - b. The Burke Company; Spartan Cote WB.
 - c. Cormix Construction Chemicals; Sealco VOC.
 - 2. Acceptable Evaporation Control Manufacturers:
 - a. Conspec Marketing and MFG. Company; Aquafilm.
 - b. Euclid Chemical Company; Eucobar.
 - c. L&M Construction Chemicals; E-Con.
- E. Evaporation retarder below temporarily reduces moisture loss from concrete surfaces awaiting finishing in hot, dry, and windy conditions. Evaporation retarders are neither curing compounds nor chemical surface retarders used to delay concrete setting.
- F. Surface Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 1. Products:
 - a. Top Cast/Top Face by Grace Products
 - b. Rugasol
 - 1) Waterbased Clear siloxane or silane penetrating sealer. Acceptable products include, but not limited to:
 - c. "Pentane"
 - d. "Weather Worker J-26 WB" or equal. (No known equal).
- G. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A, specifically manufactured for use with colored concrete.
 - 1. Products:
 - a. Anti-Hydro Company; Clear Cure Water Base
 - b. The Burke Company; Spartan Cote WB
 - c. Cormix Construction Chemicals; Sealco VOC

2.8 JOINT MATERIALS

- A. Expansion- and Isolation-Joint Materials: -Filler Strips: Premoulded material, $\frac{1}{2}$ - $\frac{3}{8}$ " thick, depth as required by slab, of resilient, non-bituminous material, depth as required by slab.

2.9 RELATED MATERIALS

- A. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- B. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:

2.10 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301 and ACI 318, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.



1. Mix design shall be the responsibility of the Contractor.
 2. Contractor shall employ a Testing Laboratory approved by the Landscape Architect under the active direction of the Civil Engineer, who shall determine mix designs to fulfill the specified requirements for strength, aggregate size and workability of concrete, and such designs shall be used in proportioning all structural concrete.
 3. Mix designs shall be submitted to the Landscape Architect for review at least 10 days prior to scheduled concrete pour.
 4. Review by the Landscape Architect shall not be considered unqualified approval, and shall not relieve the Contractor of his responsibility to furnish concrete of proper consistency and specified strengths.
 5. Provide concrete of the strengths indicated in the structural general notes
 6. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.
- B. Proportion mixtures to provide normal-weight concrete with the following properties:
1. Compressive Strength (28 Days): As indicated in the Drawings or 2500 psi.
 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.61 Select slump limit from options in subparagraph below or revise to suit Project.
 3. Slump Limit: 5 inches.
- C. Coordinate air content with decorative cement concrete pavement finishing. Trowel finishes sealing the surface before bleed water has evaporated may lead to blistering and scaling.
- D. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
1. Air Content: 2 percent
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water reducing admixture and retarding admixture [and accelerating admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

2.11 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.
1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the site and verify that no defects or errors are present that would cause defective installation or latent defects in the workmanship and function. Report unsatisfactory conditions to the College's Representative. Do not begin paving work until unsatisfactory conditions have been corrected and the area is ready to receive the work. Continuing with the installation constitutes acceptance of the unsatisfactory conditions and responsibility for satisfactory performance.
- B. Verify that paving subgrade consists of a minimum of 4-inches of compacted washed concrete sand, passes less than 7% through a #200 sieve, and is compacted to at least 95% of the materials ASTM D 1557 maximum dry density for its full depth.
- C. Verify that paving subgrade extends 1-foot beyond the outside edge of paving or curbing and has positive outfall for trapped water.
- D. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.



- E. Remove loose material from compacted subbase immediately before placing concrete.
- F. Provide necessary chairs or supports, and maintain position of reinforcing bars.
- G. Wet surface of sand subgrade prior to placing concrete.
- H. Examine exposed subgrades and subbase surfaces for compliance with tolerances for dimensional, grading, and elevation tolerances.
- I. Revise requirements in first paragraph and subparagraphs below if concrete walkways or similar lightly loaded pavements do not require this degree of proof rolling.
- J. Proof-roll prepared subbase surface with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.
- K. Completely proof-roll subbase in one direction[and repeat in perpendicular direction]. Limit vehicle speed to 3 mph.
- L. Revise minimum weight or type of vehicle in first subparagraph below if required.
- M. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
- N. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/4 inch require correction according to requirements in Division 2 Section "Earthwork."
- O. Proceed with decorative cement concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.
- P. Synthetic Fiber reinforcement; 1/2 lb. per cubic yard of mix added at batch plant.
- Q. Adjustment to Concrete Mixes: Mix design adjustments may be required by Contractor when characteristics of material, Project conditions, weather, test results, or other circumstances warrant.
- R. Coordinate with other trades, placement of accessories, chases, and other embedded items. Provide sufficient time to complete installation of their work.

3.2 SURFACE PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.
- B. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, stains, curing compounds, and sealers.
- C. Subgrade Preparation: Unless noted otherwise, subgrades shall be compacted to a relative density as specified in the soils report, and to elevations necessary to achieve the finished surface indicated. Semi-porous subgrades shall be sprinkled sufficiently with water to eliminate suction and extremely porous subgrades shall be sealed in an approved manner.
- D. Base Preparation: Where indicated, washed concrete sand or structural "CU soil base material shall be deposited at a uniform quantity that will provide the required compacted thickness within 1/4" above or below the grade determined from the Drawings. The relative compaction of the base material shall not be less than specified in the soils report. Compacted areas that do not conform to the requirements specified, shall be reworked, watered, and thoroughly re-compacted to conform to the specified requirements.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Shall conform to the shape, lines, and dimensions as called for on the Drawings.
- B. Completed formwork shall be free of hardened concrete, washed clean and shall have excess water removed, reinforcement secured in place, expansion joint material and other embedded items positioned, forms shall be thoroughly cleaned, washed out with water, and made tight. Before reinforcing steel is placed on top of or adjacent to forms that have been sealed, the surface sealer shall be wiped off so that none may be tracked over, or in any way come in contact with the reinforcing steel. Bottoms of forms shall be cleaned and wet down before placing concrete.
- C. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.



- D. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage
- E. Check completed formwork and screeds for grade and alignment to following tolerances:
 - 1. Top of Forms: Not more that 1/8-inch in 10-feet.
 - 2. Vertical Face on Longitudinal Axis: Not more that 1/4-inch in 10-feet.
 - 3. Joints and Corners: Construct forms such that joints occur at approved locations. Form intersecting planes to provide true, crisp corner with no edge grain of forms exposed to the face of the concrete. Construct exposed corners to produce smooth, solid, unbroken lines.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Sized and placed where indicated on the Drawings.
- C. The complete work shall be in place and approved a minimum of one (1) working day prior to placing of concrete.
- D. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- E. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- F. Wire Mesh: Panels shall be spliced not less than two (2) mesh openings, and shall be in placed on (1) working day prior to placing concrete. While the concrete is still plastic, the mesh shall be carefully lifted into position as specified on the Drawings.
- G. Install welded wire reinforcement in lengths as long as practicable. Flat sheets, not rolls unless otherwise accepted by College's Representative. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- H. Reinforcing Bars: Bars shall be place in accordance with the size and spacing shown of the Drawings. The bars shall be firmly and securely wired together and held in place with concrete or metal chairs. The complete work shall be in place and approve a minimum of one (1) working day prior to placing of concrete.
- I. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a 2-inch overlap to adjacent mats.
- J. Dowel: Speed Dowels, or equal (no known equal). Before reinforcing steel is placed on top of or adjacent to forms that have been sealed, the surface sealer shall be wiped off so that none may be tracked over, or in any way come in contact with the reinforcing steel. Bottoms of forms shall be cleaned and wet down before placing concrete.

3.5 JOINTS

- A. General: Construct construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated. Joints shall be no larger than 1/8" radius on sand finish concrete and 1/4" on aggregate finish concrete.
 - 1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.
 - 2. Locate as indicated on the Drawings.
- B. Construction Joints or Expansion Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at isolation joints. Joints shall be no larger than 1/8" radius on sand finish concrete and 1/4" on aggregate finish concrete.
 - 1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.



2. Provide tie bars at sides of pavement strips where indicated.
3. Dowels: Provide steel dowels across construction joints to reduce differential movement across the joint. Utilize steel dowels based upon the following:
 - a. 6-inch Thick Pavement:
 - 1) Diameter: ½-inch.
 - 2) Length: 24-inch.
 - 3) On-center Spacing: Per reinforcing schedule.
 - b. 4-inch Thick Pavement:
 - 1) Diameter: ½-inch.
 - 2) Length: 24-inch.
 - 3) On-center Spacing: Per reinforcing schedule.
4. To assist in correct alignment of steel dowels along construction joints use Speed Dowel™ plastic dowel alignment sleeves:
 - a. Insure that wood edge forms are true to line and grade prior to installing plastic dowel alignment sleeves.
 - b. Install plastic dowel sleeves on wood forms at the specified on-center dowel spacing, centered between top and bottom of wood form.
- C. Expansion/ Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
 1. Expansion material shall be placed at the appropriate elevation to achieve the depth of the sealant indicated on the Drawings. The top of the finished sealant shall be between 1/8" and 1/4" below the finished surface.
 2. Locate expansion joints at intervals as indicated on drawings, unless otherwise indicated.
 3. Extend joint fillers full width and depth of joint.
 4. Terminate joint filler, as indicated on drawings, below finished surface if joint sealant is indicated.
 5. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 6. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 7. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints or Scorelines: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows as indicated in the Drawings. Joints shall be no wider than 1/8" -1/4".
 1. Select type of joint-forming method required from two subparagraphs below or retain both at Contractor's option. Add spacing of joints if not indicated on Drawings.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
 3. Provide machine-sawn Contraction joints as soon as concrete has sufficient strength to support sawing equipment.
 4. Joints shall meet the size and depth indicated on the drawings. Joints shall be true to lines and shapes shown on the Drawings and not vary from true. Grooves shall be smooth and uniform.
 5. The completed groove at the finished surface shall not vary more than 1/32" of the width indicated.
- E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.



- B. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- C. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- D. Do not add water to concrete during delivery or at Project site.
- E. Do not add water to fresh concrete after testing.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- H. Screed pavement surfaces with a straightedge and strike off.
- I. Initial floating stage between screeding and final floating finish is included here rather than in "Concrete Protection and Curing" Article.
- J. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- K. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
- L. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by low temperatures.
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
- M. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 - 3. Fog spray forms, reinforcement steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.
- N. At the end of a work day, or when more than two hours may elapse between concrete pours, installation shall terminate at an expansion joint or other transition as shown on the Drawings.
- O. Removal of Forms: The supporting forms shall not be disturbed until the concrete has hardened sufficiently to permit their removal with safety.

3.7 CONCRETE FINISHING

- A. General: Paving finishes to match approved mock-up finishes.
- B. After placing concrete, tamp with heavy grille tamper until at least 3/8" of mortar has been brought to the surface, as soon as the surface becomes workable, push down all coarse aggregate, filling all holes and leveling surface to a true and even surface.
- C. Sand Finish or Buff Wash Finish:
- D. Finish paving to match approved mock-up and have a uniform color and texture over the entire area.
 - 1. Surfaces shall be free of ruts, grooves, dimples.



2. Edges shall be crisp and true to lines, and have finishes consistent with the field area. Float surfaces to required surfaces and planes. Finish to etch surface so that fines are exposed (no aggregate exposed.)
3. Ensure that paving surfaces receiving the finish are hand-troweled before final concrete set.
4. Match approved paving sample. It is recommended that a 2-foot x 2-foot test sample be poured from the same field mix and finished as same for each finish specified.
5. Sand or Buff Wash Finishes:
6. Light:
 - a. Light finish paving to match approved mock-up.
 - b. Thoroughly clean field pour and allow to dry.
 - c. Check for "hard spots".
 - d. Follow steps as outlined above for a light finish.
7. Heavy
 - a. Heavy finish paving to match approved mock-up.
 - b. Thoroughly clean field pour and allow to dry.
 - c. Check for "hard spots".
 - d. Follow steps as outlined above for a light finish.
8. Exposed Aggregate:
 - a. Exposed aggregate finish paving to match approved mock-up and have a uniform color and texture over the entire area.
 - b. Surfaces shall be free of ruts, grooves, dimples.
 - c. Edges shall be crisp and true to lines, and have finishes consistent with the field area. Float surfaces to required surfaces and planes. Finish to etch surface so that fines are exposed (no aggregate exposed.)
 - d. Immediately after concrete has been screeded and darbied, apply specified surface aggregate (if specified in the Drawings), evenly over entire surface, allowing no voids in coverage.
 - e. After seeding aggregate (if specified in the Drawings), embed the aggregate by hand-floating, so that top of aggregate is just below the surface.
 - f. As soon as the concrete has achieved a firm set, begin simultaneously brushing and hosting the surface with water so as to achieve a clean, uniform surface with no aggregate exposed more than 1/8-inch.
 - g. Do not dislodge or unevenly expose the surface so as to take on a "bald" spot appearance. Doing so may lead to paving rejection.

3.8 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Edge forms and intermediate screed strips shall be set accurately to produce the elevations and contours in the finished surface.
- C. After placing concrete, tamp with heavy grille tamper until at least 3/8" of mortar has been brought to the surface, as soon as the surface becomes workable, push down all coarse aggregate, filling all holes and leveling surface to a true and even surface.
- D. Initial floating operation is included in "Concrete Placement" Article.
- E. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared, and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
- F. Sandblast Finishes: Finishes shall match the approved mock-up panels, and have a uniform color and texture over the entire area. Surfaces shall be free of ruts, grooves, dimples, or swirl marks resulting from the sandblast operations. Edges shall be crisp and true to lines, and have finishes consistent with the field.
 1. Sandblast finish paving to match approved mock-up.



2. Perform sandblasting in as continuous an operation as possible, utilizing same work crew to maintain finish continuity.
 3. Provide sandblasting to a finish as indicated on Drawings.
 4. Depth of Etch: Use an abrasive sand of the required gradation and grit to expose paving surface to achieve specified etch:
 - a. Light Sand Blast: Approximately 1/32 to 3/32-inches deep.
 - b. Medium Sand Blast: Approximately 1/16 to 1/8-inches deep.
 - c. Heavy Sand Blast: Approximately 3/32 to 5/32-inches deep.
 5. Carefully blast corners and edges of paving using appropriate backup boards, in order to maintain a uniform corner or edge finish as well as prevent blast damage to adjacent surfaces and landscaping.
 6. Use same nozzle, nozzle pressure and blasting technique as used to prepare initial paving mock-ups. Exercise care to provide even and consistent strokes with air nozzle to minimize pockmarking of paving surface.
 7. Cleanup and remove expended sand particles, concrete dust, loose aggregate, and other work-related debris at end of each day's blasting operations.
- G. Washed Aggregate Finish: Finished surface shall match the approved mock-up panel in color and texture. Surfaces shall be free of ruts, grooves, dimples and have a uniform distribution of exposed coarse and fine aggregate over the entire surface area. Edges shall be crisp and true to lines, and have a finish consistent with the field area.
- H. Delete this Article if integrally colored concrete is not required.
- I. Broom Finish: After final floating, apply a hand-trowel finish followed by a broom finish to concrete.
- J. If burlap or broom finish is sole means of applying surface texture, select finishes from three subparagraphs below or revise to suit Project; otherwise, delete subparagraphs.
- K. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
- L. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
- M. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8-inch-deep with a stiff-bristled broom, perpendicular to line of traffic.
- N. Quarry Stone Finishes: Finished surface shall match the approved mock-up panel in color and texture. Surfaces shall be free of ruts, grooves, dimples and have a uniform distribution of exposed coarse and fine aggregate over the entire surface area. Edges shall be crisp and true to lines, and have a finish consistent with the field area.
1. Light:
 - a. Light Quarry Stone finish paving to match approved mock-up.
 2. Medium:
 - a. Medium Quarry Stone finish paving to match approved mock-up.
 3. Heavy:
 - a. Heavy Quarry Stone finish paving to match approved mock-up.

3.9 CONCRETE PROTECTION AND CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with the recommendations of ACI 305R for hot weather and ACI 306R for cold weather protection during curing.
- B. Evaporation Control: In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before floating.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.



- D. Curing Methods: Cure concrete by moisture curing, moisture retaining cover, curing compound, or combination of following:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with following materials:
 - a. Water.
 - b. Continuous water fog spray.
 - c. Absorptive cover, water saturated, kept continuously wet.
 - 2. Cover concrete surfaces and edges with a 12-inch lap over adjacent absorptive covers.
 - 3. Curing Compound:
 - a. Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions.
 - b. Recoat areas subjected to heavy rainfall within three hours of initial application.
 - c. Maintain continuity of coating and repair damage during curing period.
- E. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- F. Comply with ACI 306.1 for cold-weather protection.
- G. Protection and Curing: Provide and apply a sheet curing material that conforms to ASTM C 171, Standard Specifications for Sheet Material Curing Concrete. Protect concrete from defacement. All defaced concrete shall be replaced between expansion joints at no additional expense to the Owner.
- H. If evaporation rate in first paragraph below is exceeded, ACI 305R states that plastic shrinkage cracking is probable. See manufacturers' literature or ACI 305R for estimated moisture-loss chart relating relative humidity, air and concrete temperature, and wind velocity to rate of evaporation.
- I. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- J. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- K. Curing Compound: Apply curing compound immediately after final finishing. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after application. Maintain continuity of coating and repair damage during curing period.
 - 1. Cure integrally colored concrete with a pigmented curing compound.
 - 2. Cure concrete finished with pigmented mineral dry-shake hardener with a pigmented curing compound.
- L. Sealers: Prepare the finished surface and apply the penetrating sealer as recommended by the manufacturer.
- M. Curing and Sealing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.
- N. Curing Paper: Cure with unwrinkled curing paper in pieces large enough to cover the entire width and edges of slab. Do not lap sheets. Fold curing paper down over pavement edges and secure with continuous banks of earth to prevent displacement or billowing due to wind. Immediately repair holes or tears in paper.

3.10 SEALER

- A. Sealer: Apply uniformly in two coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat, at 90-degrees to the direction of the first coat using same application methods and rates.
 - 1. Begin sealing dry surface no sooner than 14 days after concrete placement or per the manufacturer's recommendations.
 - 2. Allow stained concrete surfaces to dry before applying sealer.



3.11 MIX SLIP-RESISTANT ADDITIVE THOROUGHLY IN SEALER BEFORE APPLICATION ACCORDING TO MANUFACTURER'S WRITTEN INSTRUCTIONS. STIR SEALER OCCASIONALLY DURING APPLICATION TO JOINT SEALANT

- A. Prior to applying the sealant, the joints shall be cleaned of all mortar, laitance, scale, dirt, dust, oil, curing compound, and other foreign materials. The joints and adjacent surfaces shall be dry and where called for by the manufacturer, prepared with a primer. The joints shall be filled from bottom to top without voids. All adjoining surfaces shall be protected during the sealing operations and any stains, marks, or damage resulting from the sealant operations shall be corrected.

3.12 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
 - 1. Elevation: 1/4 inch.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/4 inch.
 - 4. Lateral Alignment and Spacing of Dowels: 1 inch.
 - 5. Vertical Alignment of Dowels: 1/4 inch.
 - 6. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
 - 7. Joint Spacing: Per Geotech report.
 - 8. Contraction Joint Depth: Plus 1/4 inch, no minus.
 - 9. Sawcut Joint Width: Plus 1/8 inch-1/4", no minus.

3.13 FIELD QUALITY CONTROL

- A. Stamped cement concrete pavement projects may not need field quality-control testing. ; retain second option if Contractor engages agency. If retaining second option, retain requirement for field quality-control test reports in Part 1 "Submittals" Article.
- B. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- C. Revise field quality-control testing in first paragraph and subparagraphs below to suit Project or delete if not required for small projects.
- D. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
- E. Revise frequency of testing in subparagraph below to suit Project. First option is based on ACI 301; second option, on ACI 318 (ACI 318M) for slabs.
- F. Testing Frequency: Obtain at least 1 composite sample for each 5000 sq. ft. or fraction thereof of each concrete mix placed each day.
 - 1. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
- G. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
- H. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
- I. Concrete Temperature: ASTM C 1064/C 1064M; 1 test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and 1 test for each composite sample.
- J. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
- K. Coordinate number of compression test specimens in subparagraph above with number of compressive-strength tests in subparagraph and associated subparagraph below.



- L. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days for information and 2 specimens at 28 days.
 - 1. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.
- M. Strength of each concrete mix will be satisfactory if every average of any 3-consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- N. Test results shall be reported in writing to College's Representative, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- O. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by College's Representative but will not be used as sole basis for approval or rejection of concrete.
- P. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by College's Representative.
- Q. Remove and replace decorative cement concrete pavement where test results indicate that it does not comply with specified requirements.
- R. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.14 REPAIRS AND PROTECTION

- A. Remove and replace decorative cement concrete pavement that is broken, damaged, or does not comply with requirements in this Section in complete sections from joint to joint, unless otherwise approved by College's Representative.
- B. Detailing: Grind concrete "squeeze" left from tool placement. Color ground areas with slurry of color hardener mixed with water and bonding agent. Remove excess release agent with high-velocity blower.
- C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain decorative cement concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep decorative cement concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 16

SECTION 32 14 16
UNIT PAVERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Concrete pavers set in aggregate setting bed.
 - 2. Concrete pavers set in mortar setting bed.
- B. Related Sections include the following:
 - 1. 01 56 39 - Tree and Plant Protection
 - 2. 03 30 00 - Cast-in-place Concrete
 - 3. 03 33 10 - Landscape Site Concrete Walls
 - 4. 12 93 00 - Site Furnishings
 - 5. 31 10 00 - Site Clearing
 - 6. 31 22 00 - Grading
 - 7. 31 23 16 - Excavation
 - 8. 31 23 23 - Fill: Compacted Subbase for Paving
 - 9. 32 12 16 - Asphalt Paving
 - 10. 32 12 17 - Decomposed Granite Paving
 - 11. 32 13 13 - Concrete Paving
 - 12. 32 13 16 - Decorative Concrete Paving
 - 13. 32 84 00 - Landscape Irrigation
 - 14. 32 93 13 - Lawns and Grasses
 - 15. 32 93 16 - Exterior Plants
 - 16. 33 41 11 - Storm Utility Drainage Piping

1.2 SUBMITTALS

- A. Product Data: For the following:
 - 1. Concrete pavers.
 - 2. Mortar and grout materials.
- B. Samples for Verification: Full-size units of each type of unit paver indicated; in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.
 - 1. Provide Samples with joints grouted and cured, showing the full range of colors to be expected in the completed Work.
- C. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and College's, and other information specified.
- D. Compatibility and Adhesion Test Reports: From latex-additive manufacturer indicating the following:
 - 1. Mortar and grout containing latex additives have been tested with pavers for compatibility and adhesion.
 - 2. Interpretation of test results relative to mortar and grout performance and written recommendations for installation practices needed for adhesion.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed unit paver installations similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Source Limitations: Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.



- C. Preconstruction Compatibility and Adhesion Testing: Submit to latex-additive manufacturer, for testing indicated below, samples of paving materials that will contact or affect mortar and grout that contain latex additives.
 - 1. Use manufacturer's standard test methods to determine whether mortar and grout materials are required to obtain optimum adhesion with, and will be nonstaining to, installed pavers and other materials constituting paver installation.
 - 2. Submit a sufficient number of pavers and other materials involved in installation to allow comprehensive testing.
 - 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 4. For materials failing tests, obtain mortar and grout manufacturer's written instructions for corrective measures, including the use of alternative materials to obtain optimum bond and prevent staining.
- D. Field Mockups: Before installing unit pavers, build mockups for each form and pattern of unit pavers required to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work, including same base construction, special features for expansion joints, and contiguous work as indicated:
 - 1. Build mockups in the location and of the size indicated or, if not indicated, as directed by College's Representative.
 - 2. Notify College's Representative (7) seven days in advance of dates and times when mockups will be constructed.
 - 3. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 4. Obtain College's Representative's approval of mockups before starting unit paver installation.
 - 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 6. Demolish and remove mockups when directed.
 - 7. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect unit pavers and aggregate during storage and construction against soiling or contamination from earth and other materials.
 - 1. Cover pavers with plastic or use other packaging materials that will prevent rust marks from steel strapping.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store liquids in tightly closed containers protected from freezing.
- D. Store asphalt cement and other bituminous materials in tightly closed containers.

1.5 PROJECT CONDITIONS

- A. Weather Limitations for Mortar and Grout: Comply with the following requirements:
 - 1. Hot-Weather Requirements: Protect unit paver work when temperature and humidity conditions produce excessive evaporation of setting beds and grout. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.
 - a. When ambient temperature exceeds 90 deg F with a wind velocity greater than 8 mph, set pavers within 1 minute of spreading setting-bed mortar.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal:
 - 1. Concrete Pavers:
 - a. Type: TBD
 - 1) Tile Tech Pavers, 888-380-5575
 - b. Type: TBD
 - 1) Stepstone, Inc. 800-572-9029
 - 2. Latex-Portland Cement Mortars and Grouts:
 - a. American Olean Tile Co.
 - b. Boiardi Products Corp.
 - c. Bonsal: W. R. Bonsal Company.
 - d. Bostik.
 - e. C-Cure Corporation.
 - f. Custom Building Products.

2.2 COLORS AND TEXTURES

- A. Colors and Textures:
 - 1. Color: TBD
 - a. See hardscape legend for color and texture
 - 2. Color: TBD
 - a. See hardscape legend for color and texture

2.3 UNIT PAVERS

- A. Concrete Pavers: Solid, interlocking paving units, ASTM C 936, made from normal-weight aggregates in sizes and shapes indicated.

2.4 ACCESSORIES

- A. Job-Built Concrete Edge Restraints: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi.
- B. Cork Joint Filler: Preformed strips complying with ASTM D 1752, Type II.
- C. Compressible Foam Filler: Preformed strips complying with ASTM D 1056, Grade 2A1.

2.5 PORTLAND CEMENT MORTAR SETTING-BED MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Aggregate: ASTM C 144.
- D. Latex Additive: Per manufacturer of pavers, water emulsion serving as replacement for part or all of gaging water, of type specifically recommended by manufacturer for use with job-mixed portland cement and aggregate, and not containing a retarder.
- E. Water: Potable.

2.6 GROUT MATERIALS

- A. Latex-Portland Cement Grout: ANSI A118.6, composition as follows:
 - 1. Packaged, dry grout mix consisting of portland cement, graded aggregate, and ethylene vinyl acetate in the form of a reemulsifiable powder to which only water is added at Project site.
 - 2. Dry grout mixture indicated below combined at Project site with styrene-butadiene-rubber or acrylic-resin water emulsion serving as replacement for part or all of gaging water.

- a. Dry Grout Mixture: Factory-mixed, sanded grout complying with ANSI A118.6 and recommended by latex-additive manufacturer; in color indicated. Use latex additive without retarder with dry-set grout.
- b. Dry Grout Mixture: Factory-mixed or job-mixed sanded grout consisting of the following:
 - 1) Portland Cement: ASTM C 150, Type I or II, of natural color or white as required to produce color indicated.
 - 2) Aggregate: ASTM C 144, graded to comply with latex-additive manufacturer's requirements.
 - a) White Aggregate: Natural white sand or ground white stone.
 - b) Colored Aggregate: Ground marble, granite, or other sound stone; selected to produce required grout color.
 - 3) Colored Mortar Pigments for Grout: Natural and synthetic iron and chromium oxides, compounded for use in mortar and grout mixes. Use only pigments that have proved through testing and experience to be satisfactory for use in portland cement grout.

B. Water: Potable.

2.7 MORTAR AND GROUT MIXES

- A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimum performance characteristics. Discard mortars and grout when they have reached their initial set.
- B. Latex-Modified Portland Cement Setting-Bed Mortar: Proportion and mix portland cement, aggregate, and latex additive for setting bed to comply with directions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.
- C. Latex-Modified Portland Cement Grout: Add latex additive to dry grout mix in proportion and concentration recommended by latex-additive manufacturer. Proportion cement and aggregate to comply with directions of latex-additive manufacturer.
 1. Job-Mixed, Colored-Aggregate Grout: Custom Building Products Grout with Admix. Produce color required by drawings combining colored aggregates with portland cement of selected color.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
 1. Where pavers are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations. Examine areas where waterproofing system is turned up or flashed against vertical surfaces and horizontal waterproofing. Proceed with installation only after protection is in place.

3.2 PREPARATION

- A. Vacuum clean concrete substrates to remove dirt, dust, debris, and loose particles.
- B. Remove substances, from concrete substrates, that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
- C. Proof-roll prepared subgrade surface to check for unstable areas and areas requiring additional compaction. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase for unit pavers.

3.3 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible or cause staining in finished work.

- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
 - 1. For concrete pavers, a block splitter may be used.
- D. Joint Pattern:
 - 1. Truncated Dome Pavers: Per Plan
 - 2. Narrow Modular Pavers: Per detail.
- E. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.
 - 1. Provide joint filler, where indicated, at waterproofing that is turned up on vertical surfaces; or, if not indicated, provide temporary filler or protection until paver installation is complete.
- F. Tolerances: Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.
- G. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide joint filler as backing for sealant-filled joints where indicated. Install joint filler before setting pavers. Sealant materials and installation are specified in Division 7 Section "Joint Sealants."
- H. Expansion and Control Joints: Provide joint filler at locations and of widths indicated on details. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.
- I. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
 - 1. Install job-built concrete edge restraints to comply with requirements in Division 3 Section "Cast-in-Place Concrete." See details for curb to paver elevations and tolerances.
 - 2. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.

3.4 MORTAR SETTING-BED APPLICATIONS

- A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
- B. Apply cement-paste bond coat over surface of concrete subbase about 15 minutes before placing setting bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch thickness for bond coat.
- C. Apply mortar bed over bond coat immediately after applying bond coat. Spread and screed setting bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
- D. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Cut back, bevel edge, remove, and discard setting-bed material that has reached initial set before placing pavers.
- E. Wet brick pavers before laying if the initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at the time of laying.
- F. Place pavers before initial set of cement occurs. Immediately before placing pavers on setting bed, apply uniform 1/16-inch-thick, slurry bond coat to bed or to back of each paver with a flat trowel.
- G. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set and disturb pavers for purposes of realigning finished surfaces or adjusting joints.



- H. Spaced Joint Widths: Provide hand-tight joint width with variations not exceeding plus or minus 1/16 inch.
- I. Grout joints as soon as possible after initial set of setting bed. Force grout into joints, taking care not to smear grout on adjoining pavers and other surfaces. After initial set of grout, finish joints by tooling to produce a slightly concave polished joint, free from drying cracks.
- J. Cure grout by maintaining in a damp condition for seven days, unless otherwise recommended by latex-additive manufacturer.

3.5 REPAIR, POINTING, CLEANING, AND PROTECTION

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units as intended. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with mortar or grout. Point up joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.
- C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
 - 1. Remove protective coating as recommended by protective coating manufacturer and acceptable to unit paver and grout manufacturer. Trap and remove coating to prevent it from clogging drains.

END OF SECTION 32 14 13

SECTION 32 84 00
IRRIGATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes piping, valves, sprinklers, specialties, controls, and wiring for automatic control irrigation system.
- B. It is the intent of the specifications and drawings that the finished system is complete in every respect and to be ready for operation satisfactory to the College.
- C. The work to include all materials, labor, services, transportation, and equipment necessary to perform the work as indicated on the drawings, in these specifications, and as necessary to complete the Contract.
- D. Related Sections
 - 1. 01 56 39 - Tree and Plant Protection
 - 2. 03 30 00 - Cast-in-place Concrete
 - 3. 03 33 10 - Landscape Site Concrete Walls
 - 4. 12 93 00 - Site Furnishings
 - 5. 31 10 00 - Site Clearing
 - 6. 31 22 00 - Grading
 - 7. 31 23 16 - Excavation
 - 8. 31 23 23 - Fill: Compacted Subbase for Paving
 - 9. 32 12 16 - Asphalt Paving
 - 10. 32 12 17 - Decomposed Granite Paving
 - 11. 32 13 13 - Concrete Paving
 - 12. 32 13 16 - Decorative Concrete Paving
 - 13. 32 14 13 - Unit Paving
 - 14. 32 93 13 - Lawns and Grasses
 - 15. 32 93 16 - Exterior Plants
 - 16. 33 41 11 - Storm Utility Drainage Piping

1.2 DEFINITIONS

- A. Circuit Piping: Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.
- B. Drain Piping: Downstream from circuit-piping drain valves. Piping is not under pressure.
- C. Irrigation Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.
- D. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. FRP: Fiberglass-reinforced plastic.
 - 3. PA: Polyamide (nylon) plastic.
 - 4. PE: Polyethylene plastic.
 - 5. PP: Polypropylene plastic.
 - 6. PTFE: Polytetrafluoroethylene plastic.
 - 7. PVC: Polyvinyl chloride plastic.
 - 8. TFE: Tetrafluoroethylene plastic.
- E. Notice of Completion: The date at the close of the Maintenance Period when the work has been completed, checked, accepted, and written approval of the work has been given by the College's Representative.
- F. Date of Acceptance: The date at the end of the warranty periods as specified herein, and written acceptance has been given by the College's Representative.



- G. Finish Grade: Elevation of finished surface of planting soil within 1/10th of an inch.

1.3 CONSTRUCTION DRAWINGS

- A. Due to the scale of the drawings, it is not possible to indicate all offsets, fittings, sleeves, etc. which may be required. The Contractor to carefully investigate the structural and finished conditions affecting all of his work and plan his work accordingly, furnishing such fittings, etc. as may be required to meet such conditions. Drawings are generally diagrammatic and indicative of the work to be installed. The work to be installed in such a manner as to avoid conflicts between irrigation systems, planting, and architectural features.
- B. All work called for on the drawings by notes or details to be furnished and installed whether specifically mentioned in the specifications. When an item is shown on the plans but not shown on the specifications or vice versa, it to be deemed to be as shown on both.
- C. The Contractor to not willfully install the irrigation system as shown on the drawings when it is obvious in the field that obstructions, grade differences or discrepancies in area dimensions exist that might not have been. Such obstructions or differences should be brought to the attention of the College's Representative as soon as detected. In the event this notification is not performed, the Contractor to assume full responsibility for any revision necessary.

1.4 PERFORMANCE REQUIREMENTS

- A. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent water coverage of turf and planting areas indicated.
- B. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties, unless otherwise indicated:

- 1. Irrigation Main Piping: 280 psi.
- 2. Circuit Piping: 280 psi.

1.5 SUBMITTALS

- A. Product Data:
 - 1. Include pressure ratings, rated capacities, and settings of selected models for the following:
 - a. Irrigation controllers: Must be compatible with existing Centralized Irrigation System of the College
 - b. Master Valves
 - c. Flow Sensors
 - d. General-duty valves, Remote Control Valves Isolation Valves, Quick Couplers
 - e. Control-valve boxes.
 - f. Sprinklers, Bubblers, Check Valves
 - g. Irrigation specialties.
 - h. Control cables. Include splice kits
 - 2. After award of contract and before any irrigation system materials are delivered to the job site, submit to the College's Representative a complete list of all irrigation systems, materials, or processes proposed to be furnished and installed as part of this contract.
 - 3. The submittals to include the following information:
 - a. A title sheet with the job name, the Contractor's name, Contractor's address and telephone number, submittal date and submittal number.
 - b. An index sheet showing the item number (i.e. 1,2,3, etc.); an item description (i.e. sprinkler head); the manufacturer's name (i.e. Hunter Industries); the item model number (i.e. I-40-ADV/36V); and the page(s) in the submittal set that contain the catalog cuts.
 - c. The catalog cuts to be one or two pages from the most recent manufacturer's catalog that indicate the product submitted. Do not submit parts lists, exploded diagrams, price lists or other extra information.



- d. The catalog cuts to clearly indicate the manufacturer's name and the item model number. The item model number, all specified options and specified sizes to be circled or highlighted on the catalog cuts.
 - e. Submittals for equipment indicated on the legend without manufacturer names, or "as approved", to contain the manufacturer, Class or Schedule, ASTM numbers and/or other certifications as indicated in these specifications.
 - f. Submittal format requirements:
 - 1) Submittals to be provided as one complete package for the project. Multiple partial submittals will not be reviewed.
 - 2) Submittal package to be stapled or bound in such a way as to allow for disassembly for review processing.
 - 3) Submittal package to have all pages numbered in the lower right hand corner. Page numbers to correspond with submittal index.
 4. Manufacturer's warranties to not relieve the Contractor of his liability under the guarantee. Such warranties to only supplement the guarantee.
- B. Shop Drawings: Show irrigation system piping, including plan layout, and locations, types, sizes, capacities, and flow characteristics of irrigation system piping components. Include water meters, backflow preventers, valves, piping, sprinklers and devices, accessories, controls, and wiring. Show areas of sprinkler spray and overspray. Show wire size and number of conductors for each control cable.
- C. Coordination Drawings: Show piping and major system components. Indicate interface and spatial relationship between piping, system components, adjacent utilities, and proximate structures.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For irrigation systems, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include data for the following:
1. Automatic-control valves.
 2. Sprinklers.
 3. Controllers.
- F. Reduced plan for automatic controller.
- G. Controller watering schedule log.
- H. As-built Drawings:
1. As-built accurately on one set of Contract Drawings all changes in the work constituting departures from the original Contract Drawings.
 2. As-built drawing information and dimensions to be collected on a day-to-day basis during the installation of the pressure mainline to fully indicate all routing locations and pipe depths. Locations for all other irrigation equipment to be collected prior to the final inspection of the work.
 3. The changes and dimensions to be recorded in a legible and workmanlike manner to the satisfaction of the College. Prior to final observation of work, submit As-built Drawings to the College's Representative.
 4. Dimensions from two permanent points of reference such as buildings, sidewalks, face of curb, etc. to be shown. Data on As-built drawings to be recorded on a day-to-day basis as the project is being installed. All lettering on drawings to be minimum 1/8 inch in size.
 5. Show locations and depths of the following items:
 - a. Point of connection (including water POC, master control valves, flow sensors, etc.)
 - b. Routing of sprinkler pressure lines (dimensions shown at a maximum of 100 feet along routing)
 - c. Isolation valves
 - d. Automatic remote control valves
 - e. Quick coupling valves
 - f. Routing of control wires
 - g. Related equipment (as may be directed)



- h. Drip system air relief valves
- i. Drip system flush QC valves
- 6. Maintain As-built drawings on site at all times. Upon completion of work, transfer all as-built information and dimensions to reproducible prints.
- I. Controller Charts:
 - 1. College's Representative must approve As-built drawings before charts are prepared.
 - 2. Provide one controller chart for each automatic controller. Chart to be color-coded to clearly show valve location and area covered by the particular controller.
 - 3. Controller charts to include all drip system air relief and flush QCV's.
 - 4. The chart is to be a reduced copy of the actual "record" drawing. In the event the controller sequence is not legible when the drawing is reduced, it to be enlarged to a readable size.
 - 5. When completed and approved by College's Representative, the chart to be hermetically sealed between two pieces of plastic, each piece being a minimum 20 mils in thickness.
 - 6. Submittal of controller charts to be required before final observation and start of maintenance period walk-through.
- J. Operation and Maintenance Manuals:
 - 1. Six individually bound copies of operation and maintenance manuals to be delivered to the College's Representative at least 10 calendar days prior to final observations. The manuals to describe the material installed and the proper operation of the system. Refer to Division 1 of specifications.
 - 2. Each complete, bound manual to include the following information:
 - a. Index sheet stating Contractor's address and telephone number, duration of warranty period, list of equipment including names and addresses of local manufacturer representatives.
 - b. Operating and maintenance instructions for all equipment.
 - c. Spare parts list and related manufacturer information for all equipment.
- K. Irrigation Schedule:
 - 1. Supply as a part of this contract the following items:
 - a. One shop drawing of a bi-weekly irrigation-watering schedule for a 12-month period for approval by the College's Representative.

1.6 QUALITY ASSURANCE

- A. Provide at least one person who holds a current Certified Landscape Technician (CLT) certificate with the California Landscape Contractors Association (CLCA) as foreman to be present at all times during execution of this portion of the work and who is thoroughly familiar with the type of materials being installed and the manufacturer's recommended methods of installation and who to direct all work performed under this section.
- B. Provide photocopies of the current CLT registration for all foreman performing work on this project.
- C. Manufacturer's directions and detailed drawings to be followed in all cases where the manufacturer of articles used in this contract furnish directions covering points not shown in the drawings and specifications.
- D. All materials supplied for this project to be new or the manufacturer's current product at bid time or at least no more than 12 months old at the time of installation) and free from any defects. All defective materials to be replaced immediately at no additional cost to College.
- E. The Contractor to secure the required licenses and permits including payments of charges and fees, give required notices to public authorities, verify permits secured or arrangements made by others affecting the work of this section.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Use all means necessary to protect irrigation system materials from damage and theft before, during, and after installation and to protect the installation work and materials of all other trades. In the event of



damage or theft, immediately make all repairs and replacements necessary to the acceptance of the College's Representative and at no additional cost to the College.

- B. Exercise care in handling, loading, unloading, and storing plastic pipe and fittings under cover until ready to install. Transport plastic pipe only on a vehicle with a bed long enough to allow the pipe to lay flat to avoid undue bending and concentrated external load.
- C. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- D. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by College or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify College's Representative no fewer than two days in advance of proposed interruption of water service.
 - 2. Do not proceed with interruption of water service without College's Representative's written permission.
- B. The Contractor to verify and be familiar with the locations, size and detail of points of connection provided as the source of water, and electrical supply.
- C. Irrigation design is based on the available static water pressure shown on the drawings. Contractor to verify static water on the project prior to the start of construction. Should a discrepancy exist, notify the College's Representative prior to beginning construction.
- D. Prior to cutting into the soil, the Contractor to locate all cables, conduits, sewer septic tanks, and other utilities as are commonly encountered underground and he to take proper precautions not to damage or disturb such improvements. If a conflict exists between such obstacles and the proposed work, the Contractor to promptly notify the College's Representative. The Contractor to proceed in the same manner if a solid rock obstruction or any other such conditions are encountered.
- E. The Contractor to protect all existing utilities and features to remain on and adjacent to the project site during construction. Contractor to repair, at his own cost; all damage resulting from his operations or negligence.
- F. The Contractor to coordinate installation of required sleeves as shown on the plans.

1.9 EXISTING IRRIGATION SYSTEM

- A. The Contractor to verify and be familiar with the existing irrigation systems in areas adjacent to and within the Project area of work.
- B. The Contractor to protect all existing irrigation systems, in areas adjacent to and within the project area of work, from damage due to his operations.
- C. Contractor to notify College's Representative if any existing system is temporarily shut off, capped or modified. Provide 48-hour notice, prior to turning off of modifying any existing irrigation system.
- D. The Contractor to repair or replace all existing irrigation systems, in areas adjacent to and within the project area of work, damaged by the construction of this project. As shown on the Drawings, adjacent irrigation systems to be made completely operational and provide complete coverage of the existing landscaped areas. All repairs to be completed to the satisfaction of the College's Representative.

1.10 CONSTRUCTION OBSERVATIONS

- A. Where the specifications require work to be tested by the Contractor, it to not be covered over until accepted by the College's Representative. The Contractor to be solely responsible for notifying the College's Representative, and governing agencies, a minimum of 48 hours in advance, where and when the work is ready for testing. Should any work be covered without testing or acceptance, it to be, if so ordered, uncovered at the Design-Builder's expense.

- B. Reviews will be required for the following at a minimum:
 - 1. Finish grade in subsurface drip irrigated areas, prior to subsurface drip tubing layout.
 - 2. Pressure test of irrigation mainline (four hours at 150 PSI or 120% of static water pressure, whichever is greater.) Mainline pressure loss during test to not exceed 2 PSI.
 - 3. System layout.
 - 4. Flushing of system and verification of proper operating pressure at last head in specified zones.
 - 5. Coverage test of irrigation system.
 - 6. Coverage test of drip irrigation system, prior to backfill of area.
 - 7. Final observations prior to start of maintenance period.
 - 8. Final acceptance.
- C. Site observations and testing will not commence without current as-built drawings prepared by the Contractor. As-built mark-ups/drawings must be up to date at each site visit.
- D. Work that fails testing and is not accepted will be re-tested. The Contractor will re-test at no additional expense to the College.

1.11 CLEANUP RECYCLING AND DISPOSAL

- A. Dispose of waste, trash, and debris in accordance with applicable laws and ordinances and as prescribed by authorities having jurisdiction. Bury no such waste material and debris on the site. Burning of trash and debris will not be permitted. The Contractor to remove and dispose of rubbish and debris generated by his work and workmen at frequent intervals or when ordered to do so by the College's Representative.
- B. At the time of completion, the entire site will be cleared of tools, equipment, rubbish and debris which to be disposed of off-site in a legal disposal area.
- C. All recyclable materials are to be properly removed from site and weight tickets of the recycled materials is to be turned over to the college's Representative.

1.12 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Two (2) wrenches for disassembly and adjustment of each type of sprinkler head used in the irrigation system.
 - 2. One quick coupler key with a 1" bronze hose bib, bent nose type with hand wheel and two coupler lid keys.
 - 3. One valve box cover key or wrench.
 - 4. Three extra sprinkler heads of each size and type.
- B. The above equipment to be turned over to College's Representative at the final observation walk through.

1.13 COMPLETION

- A. A 48-hour notice to be given before any site requested observations. At the time of the pre-maintenance period observation, the College's Representative, and if not accepted, will prepare a list of items (punch list) to be completed by the Contractor. Punch list to be checked off by Contractor and submitted to College's Representative prior to any follow-up meeting. This checked off list to indicate that all punch list items have been completed. At the time of the post-maintenance period or final observation the work will be re-observed/reviewed and final acceptance will be in writing by the College's Representative.
- B. All final turnover items to be submitted prior to, or no later than final acceptance.
- C. The College's Representative to have final authority on all portions of the work.
- D. After the system has been completed, the Contractor to instruct College's Representative in the operation and maintenance of the irrigation system and to furnish a complete set of operating and maintenance instructions.



1.14 WARRANTY

- A. The entire sprinkler system, including all work done under this contract, to be unconditionally guaranteed against all defects and fault of material and workmanship, including settling of backfilled areas below grade, for a period of one (1) year following the filing of the Notice of Completion.
- B. Should any problem with the irrigation system be discovered within the warranty period, the Contractor at no additional expense to College should correct it within ten (10) calendar days of receipt of written notice from the College. When the nature of the repairs as determined by the College constitute an emergency (i.e. broken pressure line) the College may proceed to make repairs at the Contractor expense. The Contractor, all at no additional cost to the College, to repair any and all damages to existing improvement resulting either from faulty materials or workmanship, or from the necessary repairs to correct same, to the satisfaction of the College.
- C. Any settling of trenches from Finish Grade which may occur during the one-year period following acceptance to be repaired to the College's satisfaction by the Contractor without any additional expense to the College. Repairs to include the complete restoration of all damage to planting, paving or other improvements of any kind as a result of the work.

1.15 MAINTENANCE

- A. Maintenance period to be for 90 days. During the maintenance period the Contractor to adjust and maintain the irrigation system in a fully operational condition providing complete irrigation coverage at all times to all intended plantings.

PART 2 - PRODUCTS

2.1 EXISTING IRRIGATION SYSTEM

- A. The Contractor to repair or replace any existing irrigation systems damaged by this construction with products of the same manufacturer, model and size as originally used in existing irrigation system.
- B. Should any of the existing irrigation equipment no longer be available, new equipment consistent with the equipment indicated on the drawings and described in these specifications to be used to replace the unavailable equipment.
- C. Existing equipment that will be expected to be repaired or replaced if damaged will include, but is not limited to; irrigation controllers, remote control valves, remote control valve conductors, isolation valves, quick coupler valves, valve boxes, sprinkler heads, drip equipment, mainlines and lateral lines.
- D. The Contractor to be required to flush any system that demands repair or replacement. All requirements under Part 1: CONSTRUCTION OBSERVATIONS to apply to the repair and/or replacement of existing systems.
- E. The following items are a Board of Trustees Approved Sole Source Item. No substitutions will be accepted.
 - 1. Irrigation Controllers: "Weathermatic" SL4800 with SLM12 – 12 Zone Module.
 - 2. Irrigation Valves (Master & Station): "Weathermatic" 8200 Series, 10D, 12D, 15D, 20D, 25D & 30D.
 - 3. Weather Sensors: "Weathermatic" SLW5.
 - 4. Flow Sensors: "Weathermatic" SLFSI-T20, SLFSI-S30, SLFSI-S40.
 - 5. Flow Communication: "Weathermatic" SL-AIRCARDFLOW.
 - 6. Wire Connectors" "Spears" DS-400 Dr-Splice Pre-Filled.
 - 7. Quick Coupling Valves: "Rainbird" 44-LRC (Locking Rubber Cover).
 - 8. Valve Manifold Boxes (Rectangular): "Carson" Spec Grade 1419, 1730.
 - 9. Valve Box (Round): "Carson" Spec Grade 910, 2200.

2.2 PIPE

- A. All mainline pressure supply lines including the manifold 2 ½ inches in diameter and up to 3 inches in diameter downstream of the backflow prevention unit to be Schedule 80 PVC with Schedule 80 PVC fittings conforming to ASTM D1785.



- B. All lateral pressure supply lines after the manifold 2 inches in diameter and smaller downstream of the backflow prevention unit to be Schedule 40 PVC with Schedule 40 PVC fittings conforming to ASTM D1785.
- C. Pressure supply line larger than 3 inches in diameter to be Schedule 80 PVC bell and gasket with iron fittings/restraints.
- D. Non-pressure lines 3/4 inch in diameter and larger downstream of the remote control valve to be SCH 40 solvent weld PVC conforming to ASTM D1785.
- E. Pressure supply line between the water meter and the backflow prevention device to be type K copper, one size larger than backflow device. Red brass riser and fittings for the up and down legs of the backflow assembly.
- F. Reclaimed water PVC pipe to be color-coded purple in color marked on two sides with reclaimed water warning statements "Caution-Reclaimed Water". Reclaimed water piping must be accepted by the local reclaimed water governing agencies.

2.3 PLASTIC PIPE AND FITTINGS

- A. Pressure and non-pressure pipes to be virgin polyvinyl chloride SCH 80 and/or SCH 40 with manufacturer's name, trademark, size, class, type, working pressure and National Sanitation Foundation rating. All fittings to be Schedule 80 or 40 to match the piping.
- B. Threaded PVC pipe and nipples to be PVC sch. 80. All threaded fittings and nipples to be wrapped with Teflon tape prior to assembly. No liquid tape.
- C. Pipe to be marked continuously with manufacturer's name, nominal pipe size, schedule or class, PVC type and grade, National Sanitation Foundation approval, Commercial Standards designation, and date of extrusion.
- D. All plastic pipes to be extruded of an improved PVC virgin pipe compound in accordance with ASTM D2241 or ASTM D1784.
- E. All solvent weld PVC fittings to be standard weight Schedule 40 and (Schedule 80 where specified on the irrigation drawings) and to be injection molded of an improved virgin PVC fitting compound. Slip PVC fittings to be the "deep socket" bracketed type. Threaded plastic fittings to be injection molded. All tees and ells to be side gated. All fittings to conform to ASTM D2466.
- F. All threaded nipples to be standard weight Schedule 80 with molded threads and to conform to ASTM D1785.
- G. All plastic pipe pressure lines to be solvent welded with a two-step process, using primer and solvent cement. All non-pressure laterals to be solvent welded with a one-step integral primer/solvent. Cement to be of a fluid consistency, not gel-like or ropy. Solvent cementing to be in conformance with ASTM D2564 and ASTM D2855.
- H. When connection is plastic to metal, female adapters to be hand tightened, plus one turn with a strap wrench. Joint compound to be non-lead base Teflon paste or tape.

2.4 METAL PIPE AND FITTINGS

- A. Brass pipe to be 85 percent red brass, ANSI, IPS Standard 125 pounds, Schedule 40 screwed pipe.
- B. Fittings to be medium brass, screwed 125-pound class.
- C. Copper pipe and fittings to be Type "K" sweat soldered.
- D. All metal pipe below ground or encased within concrete is to be wrapped with pipe tape.

2.5 VALVES

- A. Ball Valves
 - 1. All Ball Valves 2.5" and less shall be G4 Curb Stop Isolation – No Exception
 - a. Ford Model B11
 - b. Approved Equivalent.

2. All Ball Valves 2.5" or greater shall be Clow Resilient Wedge Lock Gate Valves with stainless steel bolts.
 3. Ball valves to be constructed of a full port bronze body, stainless steel ball, stem and stainless steel handle and is to be installed with the handle in an upward position when turned off
 4. All ball valves to have a minimum working pressure of not less than 150 PSI and to conform to AWWA standards.
 5. Use ball valves at point of connection, mainline change of direction and at points of isolation for manifolds and quick couplers.
- B. Quick Coupler Valves:
1. Quick coupler valve shall be Rain Bird 44LRC (Locking Rubber Cover), with Snap-Lok pre-assembled PVC swing joint with male brass stabilizer elbow and Snap-Lok collar manufactured by LASCO. Assembly to be housed in a CARSON 910 circular valve box supported by three (3) bricks with gravel beneath and up to base of coupler.
- C. Master Valves
1. Remote control valves to be as manufactured by Weathermatic, model number 8200CR Bronze valve. Size per drawings. This is a necessary item, that is only available from the listed source, or it is required to match existing Campus standards, and no other product to be furnished.
 - a. "Weathermatic" Irrigation Controllers are a Board of Trustees Approved Sole Source Item. No substitutions will be accepted.
 2. Remote control valves to be electrically operated.
 3. Remote control valves to have a yellow station ID tag or recycled water warning ID tag (for recycled systems) attached to the valve stem.
- D. Remote Control Valves:
1. Remote control valves to be as manufactured by Weathermatic, model number 8200CR Bronze valve. Size per drawings. This is a necessary item, that is only available from the listed source, or it is required to match existing Campus standards, and no other product to be furnished.
 2. Remote control valves to be electrically operated.
 3. Remote control valves to have a yellow station ID tag or recycled water warning ID tag (for recycled systems) attached to the valve stem.
- E. Drip Valve with Pressure Regulator and Filter Assembly
1. Drip Valve with Pressure Regulator and Filter Assembly to be as manufactured by Rain Bird, model number PRB-QKCHK-100. This is a necessary item, that is only available from the listed source, or it is required to match existing Campus standards, and no other product to be furnished.
- F. In-line drip tubing
1. In-line drip tubing shall be sub-surface type, have root guard protection through copper shield technology and be as manufactured by Rain Bird, model XFS-XX-XX.
- G. Drip system Air Relief Valves
1. Drip System Air Relief Valves to be as manufactured by Rain Bird, model number ARV050 with pop-up indicator. This is a necessary item, that is only available from the listed source, or it is required to match existing Campus standards, and no other product to be furnished.
- H. Drip system Flush Valves
1. Drip system flush valves to be manual flush valve model# TLISOV manufactured by NETAFIM. This is a necessary item, that is only available from the listed source, or it is required to match existing Campus standards, and no other product to be furnished. KBI valves not allowed.

2.6 VALVE BOXES

- A. Valve boxes to be fabricated from a durable, weather-resistant plastic material resistant to sunlight and chemical action of soils as manufactured by CARSON, to match existing. This is a necessary item, that is only available from the listed source, or it is required to match existing Campus standards, and no other product to be furnished.



1. The valve box cover to be of the overlapping type and secured with a hidden latching mechanism or bolts.
2. The cover and box to be capable of sustaining a load of 1,500 pounds.
3. Cover and box to be either green (potable water) or purple (reclaimed water).
4. Valve box extensions to be by the same manufacturer as the valve box.
5. Automatic control valve boxes to be CARSON 1419 12" depth rectangular model for typical remote control valves and CARSON 1730 12" depth jumbo rectangular model for drip irrigation remote control valve, filter, and pressure regulator assembly. Heat branding RVC on valve boxes. No numbering (college standard).
6. Ball valve and quick coupler valve boxes to be CARSON 910 10" round model. Valve box covers to be marked with either "BV" or "QCV" "heat branded" onto the cover in 2-inch high letters.

2.7 TAGS FOR VALVES AND IRRIGATION COMPONENTS

- A. Provide 2-sided tags for all valves and irrigation component identification as manufactured by Christy, to match existing. This is a necessary item, that is only available from the listed source, or it is required to match existing Campus standards, and no other product to be furnished.

2.8 IRRIGATION CONTROL SYSTEM COMPONENTS (DETAILED CONFIGURATION NEEDS TO BE COORDINATED WITH IRRIGATION CONSULTANT)

- A. "Weathermatic" Irrigation Controllers are a Board of Trustees Approved Sole Source Item. No substitutions will be accepted.
 1. Irrigation Controller Unit: Irrigation controller shall be Weathermatic SL4800 w/SLM12 – 12 Zone Module. This is a necessary item, that is only available from the listed source, or it is required to match existing Campus standards, and no other product to be furnished.
 2. Weather Sensor: Weather sensor shall be Weathermatic model # SLW5. This is a necessary item, that is only available from the listed source, or it is required to match existing Campus standards, and no other product to be furnished.
 3. Flow Sensor: Flow sensor shall be Weathermatic model # SLFSI-T20, SLFSI-S30 or SLFSI-S40. This is a necessary item, that is only available from the listed source, or it is required to match existing Campus standards, and no other product to be furnished.
 4. Flow Communication: Flow communication module shall be Weathermatic SL-AIRCARDFLOW. This is a necessary item, that is only available from the listed source, or it is required to match existing Campus standards, and no other product to be furnished.
 5. Irrigation Controller Enclosure:
 - a. All Locations: Weathermatic SLPED-ENC-SS-4800
 - b. Wall-Mounted (where required): SLWM-SS-4800

2.9 ELECTRICAL

- A. All electrical equipment to be NEMA Type 3, waterproofed for exterior installations.
- B. All electrical work to conform to local codes and ordinances.

2.10 LOW VOLTAGE CONTROL WIRING

- A. Remote control wire to be direct-burial AWG-UF type. Wires to be AWG 14 (black or red only) for control, and AWG 14 (white only) for common.
 1. Wire Splice Connectors to be SPEARS, model DS-400. This is a necessary item, that is only available from the listed source, or it is required to match existing Campus standards, and no other product to be furnished.

2.11 IRRIGATION HEADS AND DRIP TUBING

- A. Description: Brass or plastic housing and corrosion-resistant interior parts designed for uniform coverage over entire spray area indicated, at available water pressure.
- B. Irrigation heads and drip tubing to be of the manufacturer, size, type, with radius of throw, operating pressure, and discharge rate indicated on the drawings unless otherwise specified below.
 1. In-line drip tubing shall be Rain Bird XFS-XX-XX (flow rate and emitter spacing per plan)



2. In-line drip tubing connectors to be Rain Bird XF dripline fittings.
 3. Bubbler Nozzles – Hunter MSBN-25Q.
 4. Spray Head Bodies with factory installed pressure regulator and check valve, 6-inch (for tree bubbler) 6- inch (at turf), and 12-inch (at shrub/bioswale) pop up as manufactured by Rain Bird or Hunter. Do not use pre-made swing assembly. Use three marlex with SCH 80 nipple. 6" i25 heads are preferred for larger turf areas.
 5. Rotary Nozzles as manufactured by Hunter Industries, model MP Rotator Series. For larger areas use I-20s or I-40s.
 6. College to approve any additional heads on a case-by-case basis.
- C. Irrigation heads and drip tubing to be used as indicated on the drawings.
- D. Drip tubing connections to PVC lateral lines (SUPPLY/EXHAUST HEADER) to be made using Rain Bird XF dripline fittings.

2.12 DRIP EQUIPMENT

- A. Drip equipment such as Drip RCV assembly kits, flush valves, air relief valves, emission devices, poly tubing, and basket strainers to be of the manufacturer, size, and type indicated on the drawings.

2.13 MISCELLANEOUS EQUIPMENT

- A. Equipment such as rain sensors (SLW5), flush valves, flow sensors, basket strainers, and master valves to be of the manufacturer, size and type indicated on the drawings. District specified choice: Weathermatic

PART 3 - EXECUTION

3.1 PREPARATION

- A. Observations:
1. Prior to all work of this section, carefully observe/review the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
 2. Verify that irrigation system may be installed in strict accordance with all pertinent codes and regulations, the original design, the referenced standards, and the manufacturer's recommendations.
- B. Discrepancies:
1. In the event of discrepancy, immediately notify the College's Representative.
 2. Do not proceed with installation in areas of discrepancy until all discrepancies have been resolved.
- C. Grades:
1. Before starting work, carefully check all grades to determine that work may safely proceed, keeping within the specified material depths with respect to finish grade.
 2. Final grades to be accepted by the College's Representative before work on this section will be allowed to begin.
- D. Field Measurements:
1. Make all necessary measurements in the field to ensure precise fit of items in accordance with the original design. Contractor to coordinate the installation of all irrigation materials with all other work.
 2. All scaled dimensions are approximate. The Contractor to check and verify all size dimensions prior to proceeding with work under this section.
 3. Exercise extreme care in excavating and working near existing utilities. Contractor to be responsible for damages to utilities that are caused by his operations or neglect.
- E. Diagrammatic Intent:
1. The drawings are essentially diagrammatic. The size and location of equipment and fixtures are drawn to scale where possible. Provide offsets in piping and changes in equipment locations as necessary to conform to structures and to avoid obstructions or conflicts with other work at no additional expense to College.



- F. Layout:
 - 1. Prior to installation, the Contractor to stake out all pressure supply lines, routing and location of sprinkler heads, valves, and backflow device, and automatic controller. Obtain College's Representative's approval before excavation.
 - 2. Layout irrigation systems and make minor adjustments required due to differences between site and drawings. Where piping is shown on the drawings under paved areas, but running parallel and adjacent to planted areas, install the piping in the planted areas.
- G. Water Supply:
 - 1. Connections to, or the installation of, the water supply area to be at the locations shown on the drawings. Changes caused by actual site conditions to be made at no additional expense to College.

3.2 EARTHWORK

- A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.
- B. Install Christy's detectable warning tape as described in the irrigation legend directly above pressure piping, 12 inches below finished grades, except 6 inches below subgrade under pavement and slabs.
- C. Excavations to be straight with vertical sides, even grade, and support pipe continuously on bottom of trench. Trenching excavation to follow layout indicated on drawings to the depths below finished grade and as noted. Where lines occur under paved area, these dimensions to be considered below sub grade.
- D. Install piping and wiring in sleeves under sidewalks, roadways, parking lots, and railroads.
 - 1. Install piping sleeves by boring or jacking under existing paving if possible.
- E. Drain Pockets: Excavate to sizes indicated. Backfill with cleaned gravel or crushed stone, graded from 3/4 to 3 inches, to 12 inches below grade. Cover gravel or crushed stone with sheet of asphalt-saturated felt and backfill remainder with excavated material.
- F. Provide minimum cover over top of underground piping according to the following:
 - 1. Irrigation Main Piping: Provide minimum cover of 18 inches on pressure supply lines 2 1/2 inches and smaller in landscaped areas.
 - a. Mainlines over 2 1/4' inches provide minimum cover of 18 inches minimum on pressure supply lines.
 - 2. Circuit Piping: Provide minimum cover of 12 inches for non-pressure lines in landscaped areas.
 - 3. Drain Piping: 12 inches.
 - 4. Sleeves under Sidewalks and pathways: Provide 18" below sidewalks and pathways for both pressure supply lines and non-pressure lateral lines. Sleeves need to extend a minimum of 6" beyond the edges of the sidewalks and pathways.
 - 5. Sleeves under Roadway: Provide 36" below paving for pressure supply line. Provide 24" cover for non-pressure lines and wire sleeves.
 - 6. Provide minimum cover of 18 inches for control wires in landscaped areas. Control wires should, where possible, share the same trench as the pressurized mainlines and be separated by 6 inches and not allowed to cross wrap or snake around the mainline.
 - 7. Pipes installed in a common trench to have a 4-inch minimum space between pipes.

3.3 BACKFILLING

- A. Backfill material on all lines to be the same as adjacent soil free of debris, litter, and rocks over 1/2 inch in diameter.
- B. Backfill to be tamped in 4-inch layers under the pipe and uniformly on both sides for the full width of the trench and the full length of the pipe. Backfill materials to be sufficiently damp to permit thorough compaction, free of voids. Backfill to be compacted to 85% relative dry density in planting areas, dry density equal to adjacent undisturbed soil and to conform to adjacent grades.
- C. Flooding in lieu of tamping is not allowed.
- D. Under no circumstances to truck wheels be used to compact backfill.
- E. Provide sand backfill a minimum of 6 inches over and under all piping under paved areas.

- F. Backfilling of mainlines prior to pressure testing is not allowed. Only center loading of mainlines prior to testing is acceptable to allow all mainline joints and fittings to be visible during testing.

3.4 PIPING INSTALLATION

- A. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.
- B. Install piping at minimum uniform slope of 0.5 percent down toward drain valves.
- C. Install piping free of sags and bends.
- D. Install groups of pipes parallel to each other, spaced to permit valve servicing.
- E. Install fittings for changes in direction and branch connections.
- F. Install unions adjacent to valves and to final connections to other components with NPS 2 or smaller pipe connection.
- G. Install flanges adjacent to valves and to final connections to other components with NPS 2-1/2 or larger pipe connection.
- H. Piping under existing pavement may be installed by jacking, boring, or hydraulic driving. No hydraulic driving is permitted under asphalt pavement.
- I. Piping in control-valve boxes and above ground may be joined with flanges instead of joints indicated.
- J. Carefully inspect all pipe and fittings before installation, removing dirt, scale, burrs, and reaming. Install pipe with all markings up for visual inspection and verification.
- K. Remove all dented and damaged pipe sections.
- L. All lines to have a minimum clearance of 4 inches from each other and 12 inches from lines of other trades.
- M. Parallel lines to not be installed directly over each other.
- N. In solvent welding, use only the specified primer and solvent cement and make all joints in strict accordance with the manufacturer's recommended methods including wiping all excess solvent from each weld. Allow solvent welds at least 15 minutes setup time before moving or handling and 24 hours curing time before filling.
- O. PVC pipe to be installed in a manner, which will provide for expansion and contraction as recommended by the pipe manufacturer.
- P. Center load all plastic pipe prior to pressure testing.
- Q. All threaded plastic-to-plastic connections to be assembled using Teflon tape or Teflon paste.
- R. For plastic-to-metal connections, work the metal connections first. Use a non-hardening pipe dope on all threaded plastic-to-metal connections, except where noted otherwise. All plastic-to-metal connections to be made with plastic male adapters.
- S. Install dielectric fittings to connect piping of dissimilar metals.
- T. Install underground thermoplastic piping according to ASTM D 2774 and ASTM F 690.
- U. Lay piping on solid subbase, uniformly sloped without humps or depressions.
- V. Install Thrust Blocks or Kick Blocks at locations where mainlines turn at 45's or 90's or where tees are installed.
- W. Install ductile iron-piping according to AWWA C600.
- X. Install PVC piping in dry weather when temperature is above 40 deg F 5 deg C. Allow joints to cure at least 24 hours at temperatures above 40 deg F 5 deg C before testing unless otherwise recommended by manufacturer.
- Y. Pressure Test: All pressure lines to be tested under hydrostatic pressure.

- Z. Coverage Test: When the sprinkler system is completed a coverage test to determine if coverage is complete and adequate to be performed.

3.5 CONTROL WIRING

- A. Low voltage control wiring to occupy the same trench and to be installed along the same route as the pressure supply lines whenever possible.
- B. Where more than one wire is placed in a trench, the wiring to be taped together in a bundle at intervals of 10 feet. Bundle to be placed alongside the mainline and separated by 6 inches and not allowed to cross wrap or snake around mainline. Metallic defector tape should be placed above the wire bundle at the depth of 12 inches below finish grade. All connections to be of an approved type and to occur in a valve box. Provide an 18-inch service loop at each connection.
- C. An expansion loop of 12 inches to be provided at each wire connection and/or directional change, and one of 24 inches to be provided at each remote control valve.
- D. A continuous run of wire to be used between a controller and each remote control valve. Under no circumstances to splices be used.

3.6 VALVE INSTALLATION

- A. Automatic control valves, quick coupler, and isolation valves are to be installed in the approximate locations indicated on the drawings.
- B. Valves to be installed in shrub areas.
- C. Install all valves as indicated in the detail drawings.
- D. Valves to be installed in valve boxes to be installed one valve per box.

3.7 VALVE BOX INSTALLATION

- A. Valve boxes to be installed in shrub areas whenever possible.
- B. Each valve box to be installed on a foundation of 3/4 inch gravel backfill, 6" deep extending 6" beyond the perimeter of the box, minimum. Valve boxes to be installed with their tops 1/2 inch above the surface of surrounding finish grade in lawn areas and 3 inches above finish grade in ground cover areas.
- C. Valve boxes are to be supported by bricks set into gravel foundation.
- D. Seal all below-grade opening in valve boxes and around piping to prevent soil from entering the valve box through the use of geotextile fabric. Do not use cardboard duct tape or other materials that will deteriorate in wet conditions.

3.8 IRRIGATION HEADS AND DRIP TUBING INSTALLATION

- A. Irrigation heads and drip tubing to be installed as indicated on the drawings.
- B. Spacing of heads and drip tubing to not exceed maximum indicated on the drawings.
- C. Riser nipples to be of the same size as the riser opening in the sprinkler body.
- D. Flush circuit piping with full head of water and install sprinklers after hydrostatic test is completed.
- E. Locate part-circle sprinklers to maintain a minimum distance of 12 inches from walls and other boundaries in shrub areas and 3 inches from boundaries in turf areas, unless otherwise indicated.

3.9 MISCELLANEOUS EQUIPMENT

- A. Install all assemblies specified herein according to the respective detail drawings or specifications, using best standard practices.
- B. Quick coupler valves to be set approximately within 18 inches from walks, curbs, header boards, or paved areas where applicable.
- C. Install devices such as flush valves, air relief valves and flow sensors as indicated on the drawings and as recommended by the manufacturer.

3.10 FIELD QUALITY CONTROL

- A. Refer to Part 1 "Construction Observations" Article for all field quality control requirements.

3.11 STARTUP SERVICE

- A. Verify that controllers are installed and connected according to the Contract Documents.
- B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
- C. Complete startup checks according to manufacturer's written instructions.
- D. Prior to installation of irrigation heads, the valves to be opened and a full head of water used to flush out the lines and risers.
- E. Irrigation heads to be installed after flushing the system has been completed.
- F. All drip-tubing lines to be open prior to flushing. As lines are flushed the tubing ends may be connected together per plan.

3.12 ADJUSTING

- A. Contractor to adjust valves, align heads, and check the coverage of each system prior to coverage test.
- B. If it is determined by the College's Representative that additional adjustments or nozzle changes will be required to provide proper coverage, all necessary changes or adjustments to be made prior to any planting.
- C. The entire system to be operating properly before any planting operations commence.
- D. Automatic control valve pressure regulators are to be adjusted so that the irrigation heads and drip tubing operate at the pressure recommended by the manufacturer.
- E. Adjust automatic control valves to provide flow rate of rated operating pressure required for each sprinkler circuit.
- F. Adjust sprinklers so they will be flush with, or not more than 1/2 inch above, finish grade.

3.13 EXISTING IRRIGATION SYSTEM

- A. All repair or replacement of the existing irrigation systems to be consistent with the methods indicated on the drawings and as described in these specifications.
- B. If existing equipment is significantly different from the equipment indicated on the drawings and described in these specifications, the Contractor to install the equipment in a manner consistent with the manufacturer's recommendations.
- C. Sprinkler system lines that cross into the area of new construction to be cut and capped at the limit of work line. If the remote control valves that control an area are located on the new work side of the limit of work, they to be relocated across the line and made completely operational controlling the system that covers the adjacent existing area. Major equipment such as controllers, isolation valves and mainline to be relocated as required to continue service to existing irrigation systems outside of the area of new work.

3.14 TESTING AND OBSERVATION

- A. Do not allow or cause any of the work of this section to be covered up or enclosed until it has been observed, tested and accepted by the College's Representative.
- B. The Contractor to be solely responsible for notifying the College's Representative a minimum of 48 hours in advance, where and when the work is ready for testing.
- C. When the sprinkler system is completed, the Contractor to perform a coverage test of each system in its entirety to determine if the water coverage for the planted areas is complete and adequate in the presence of the College's Representative.
- D. The Contractor to furnish all materials and perform all work required to correct any inadequacies of coverage due to deviations from the plans, or where the system has been willfully installed as indicated on the drawings when it is obviously inadequate, without bringing this to the attention of the College's



Representative. This test to be accepted by the College's Representative and accomplished before starting any planting.

- E. Final observations will not commence without As-built drawings as prepared by the Design-Builder.

3.15 CLEAN UP

- A. As the work progresses, maintain areas in a neat, clean orderly manner, and remove unsightly debris as necessary. At the completion of the work, sweep and clean all walks, parking and other paved areas adjacent to plantings.
- B. During irrigation installation, keep adjacent paving and construction clean and work area in an orderly condition.
- C. Protect exterior plants, lawns and hydroseeding from damage due to landscape operations, operations by other Contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged exterior planting.
- D. Any damage sustained on the work of others to be repaired to original conditions.
- E. Flush dirt and debris from piping before installing sprinklers and other devices.

3.16 DISPOSAL

- A. Disposal: All grubbed material, rock, surplus soil and waste material, including excess subsoil, unsuitable soil, trash and other debris to be removed from the College's property and disposed of in a legal disposal site.
- B. Recycling: All recyclable materials are to be properly removed from site and weight tickets of the recycled materials to be turned over to the College's Representative.

3.17 DEMONSTRATION

- A. Engage a factory-authorized service representative to train College's maintenance personnel to adjust, operate, and maintain controller and automatic control valves. Refer to Division 1 Section "Closeout Procedures."

3.18 MAINTENANCE

- A. General Irrigation: Continually maintain irrigation system in working order, adjusting system for proper soil moisture content, proper operating pressure, proper coverage including elimination of overspray or run off.
- B. Watering Schedule Log: Maintain an irrigation controller water schedule log during construction and maintenance indicating water schedules and changes.
- C. Maintenance Specifications: Provide complete annual maintenance specifications including general irrigation system design intent and estimated watering schedule based on planting and irrigation system design.

END OF SECTION 32 84 00



**SECTION 32 93 13
LAWNS AND GRASSES**

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Section Includes: Seeding, Hydroseeding, Plugging, Meadowgrass and wildflower, Turf installation, turf establishment and minimum 90 days maintenance.
- B. Related Sections
 - 1. 01 56 39 Tree and Plant Protection
 - 2. 03 30 00 Cast-in-place concrete
 - 3. 03 33 10 Landscape Site Concrete Walls
 - 4. 12 93 00 Site Furnishings
 - 5. 31 10 00 Site Clearing
 - 6. 31 22 00 Grading
 - 7. 31 23 16 Excavation
 - 8. 31 23 23 Fill: Compacted Subbase for Paving
 - 9. 32 12 16 Asphalt Paving
 - 10. 32 12 17 Decomposed Granite Paving
 - 11. 32 13 13 Concrete Paving
 - 12. 32 13 16 Decorative Concrete Paving
 - 13. 32 14 13 Unit Paving
 - 14. 32 84 00 Landscape Irrigation
 - 15. 32 93 16 Exterior Plants
 - 16. 33 41 11 Storm Utility Drainage Piping

1.2 GENERAL REQUIREMENTS/DEFINITIONS

- A. Notice of Completion: The date at the close of the Maintenance Period when the work has been completed, checked, accepted, and written approval of the work has been given by the College's Representative.
- B. Date of Acceptance: The date at the end of the warranty periods as specified herein, and written acceptance has been given by the College's Representative.
- C. Finish Grade: Elevation of finished surface of planting soil within 1/10th of an inch.
- D. Import soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- E. Native Soil: Soil found in place in the designated landscape area, including soil compacted in place as part of the earthwork specified for the project.
- F. Planting Area: Areas to be planted with trees, shrubs, groundcovers, lawn, or seed, or areas to be covered with various gravel or stone mulches not intended for pedestrian or vehicular circulation.
- G. Planting Soil: Native or imported soil modified to become planting soil; mixed with soil amendments.
- H. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.
- I. To Remain: Protect and maintain at all times the existing plant material as identified on the Drawings.
- J. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.



- K. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, ground squirrels, voles and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

1.3 SUBMITTALS

- A. Soil Analysis:
 - 1. Soil Analysis: Soil analysis test reports shall be completed after rough grading to determine actual recommended soil amendments. Refer to Part 1.05: Soil Testing.
- B. Product Data and Samples:
 - 1. Product Data: For each type of product specified.
 - 2. Soil amendments and fertilizers: Submit supplier/manufacturer's product data on amendments and fertilizers as noted. Include brand names, estimated quantities, and supplier.
- C. Certification of Grass Sod: From sod vendor for each sod type. Refer to drawings for sod species and vendor.
- D. Seed mix: Submit a seeds list with quantities, purity, germination rate, additives and supplier
- E. Product Certificates: For each type of manufactured product, signed by product manufacturer, and complying with the following:
 - 1. Manufacturer's certified analysis for standard products.
 - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- F. Qualification Data: For landscape Installer. Refer to Part 1, Section "Quality Assurance".
- G. Material Test Reports: For existing surface soil and imported topsoil.
- H. Planting Schedule: Indicating anticipated planting dates for each type of planting.
- I. Maintenance Instructions: Prepare instructions for maintenance in cooperation with the Owner for maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods. Instructions shall include but not be limited to the following tasks:
 - 1. Fertilizing
 - 2. Irrigation schedule

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: All of the work required to be provided as described in this Section of the Specifications shall be provided by a single entity sub-contractor skilled in this specialty, holding a valid C-27 California contractor's license.
- B. The qualified landscape installer shall exhibit work that has resulted in successful lawn and seed establishment. Submitted qualifications shall include a client list with contact names, phone numbers and date lawn was installed.
- C. All work shall be performed by a trained crew company in accordance with the standards and practices related to the trade.
- D. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.
- E. Full-time Supervisor: Require full-time Supervisor to hold a current Certified Landscape Technician (CLT) certificate with the California Landscape Contracts Association (CLCA) to be present at all times during execution of this portion of the work who is thoroughly familiar with the type of installation and who is to direct all work performed under this section.
- F. Provide photocopies of the current CLT registration for all foreman performing work on this project.
- G. Reference Standards: Reference Standards apply to this Sections and shall be the latest edition of the following:



1. "Seed Laws" State of California Department of Food and Agriculture
2. "Seed Laws" U.S. Department of Agriculture
3. Hortus Third
4. Sunset Western Garden Book, Sunset Publishing Corporation
5. The Jepson Manual, Owner of California Press, Berkeley

1.5 SUBMITTALS

A. SOIL TESTING

1. Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
2. Supply Soil Testing Laboratory with complete copy of 32 93 13 specification sections at time of soil tests.
3. Soil Testing After Rough Grading
 - a. At the conclusion of rough grading, collect soil samples per plan (minimum 5), and submit the samples to an agricultural soils laboratory for testing. Submit the test results to the College's Representative for review. No amendments shall be applied prior to receipt of test results. The College's Representative shall recommend changes to the amendments and/or procedure listed herein, after review of the test results. Costs for testing shall be included in the contract. Changes in amendments and/or procedures shall be authorized by the Owner in accordance with the provisions of the General Conditions Article "Changes in the Work".
 - b. A soil analysis shall be made after rough grading operations are complete to determine actual recommended soil amendments.
 - c. Soil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter, textural classification, textural tests, silt sand clay content, sodium absorption rate (SAR), electrical conductivity (ECe), cation exchange capacity, boron content, deleterious material, pH, mineral and plant-nutrient content of topsoil and elemental data, corrective recommendations and soil amendment recommendations.
 - d. Report suitability of topsoil for plant growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil.

B. Qualification Data: For landscape Installer.

C. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

D. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

1.6 OBSERVATION

A. College's Representative may observe lawn and seed mixes on site before planting for compliance with requirements for genus, species, variety, size, and quality. College's Representative retains right to observe lawn further for size and condition of root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove lawn immediately from Project site.

1. Notify College's Representative of sources of sod fourteen days in advance of delivery to site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Sod: Deliver sod to be planted at time of delivery.

B. Seed: Deliver seed in original sealed, labeled and undamaged containers.



1.8 COORDINATION

- A. Planting Restrictions: Plant during one spring or fall. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
- B. Weather Limitations: Proceed with planting and seeding only when existing and forecasted weather conditions permit.
- C. Coordination with Exterior Plants: Plant trees and shrubs after finish grades are established and before planting lawns, from sod or seed, unless otherwise acceptable to College's Representative.
 - 1. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.

1.9 LAWN MAINTENANCE

- A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:
 - 1. Sodded Lawns: 90 days minimum from date of Final Completion.
 - a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.
 - 2. Seeded areas: 90 days minimum from date of Final Completion.
 - a. Begin maintenance immediately after each area has established enough root growth to withstand any damage from maintenance foot traffic, equipment, and other exposures typical of turf maintenance and continue until acceptable seeding is established (100% coverage with no weeds), but not less than 90 days from date of substantial completion.
- B. Maintain seeding by watering, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and re-mulch as needed to provide 100% coverage.
- C. Within one week following authorization to start maintenance period, submit a Maintenance Schedule to the College's Representative listing the days when maintenance crews will be on site. In the schedule provide a contact person and emergency phone number.
- D. The Maintenance Period shall be extended, when in the opinion of the College's Representative, dead or dying plant materials, poor or unhealthy growing conditions, or improper maintenance practices are evident within the maintenance period. The extended period shall be provided at no additional cost to the Owner, and shall be extended until the work is complete and acceptable to the College's Representative.
- E. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas
- F. Watering: Keep lawn uniformly moist to a depth of 4 inches. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.
- G. Water lawn at a minimum rate of 1 inch per week.
- H. Watering: Keep seeding uniformly moist. If a permanent irrigation of ½" per week for 8 weeks after planting or per the seed supplier's recommendations.
- I. Mow lawn only after sufficient root growth has been established in order to withstand any damage from maintenance foot traffic, equipment and other exposures typical of turf maintenance and top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
 - 1. Retain applicable mowing heights below.
 - a. Hybrid Bermuda 3/8"-1" with a Reel mower.
 - b. Turf-type Tall Fescue 1-3" with Rotary mower.



- J. Lawn Post fertilization: Apply fertilizer after initial mowing and when grass is dry.
 - 1. (for Fescue and Bermuda) Use fertilizer that will provide actual nitrogen of at least 1 lb./1000 sq. ft. to lawn area.

1.10 REJECTION AND SUBSTITUTION

- A. Products or materials, whether installed or not, not conforming to the requirements herein specified shall be considered defective, and be marked as rejected. Materials shall be removed and replaced with approved materials at no additional cost to the Owner.
- B. Submit written request for each proposed substitution. Provide data substantiating request as well as a "Certificate of Suitability" certifying that the proposed substitution is equal or better in all respects to that specified and that it will, in all respects perform the function for which it is intended. Include with request all required samples. Submit 3 copies of all written requests and data for proposed substitution.

1.11 SITE OBSERVATIONS

- A. Schedule and coordinate site observation visits for the following construction activities. Reviews shall be performed by the College's Representative and notification shall be given in advance as noted:

<u>Item</u>	<u>Advance Notice</u>
1. Protection of existing plant materials	48 hours
2. Rough grade and soil tests	48 hours
3. Soil preparation and finish grade	8 hours
4. Percolation tests	48 hours
5. Plant material review	48 hours
6. Plant layout and installation	48 hours
7. Substantial Completion Punch List	7 days
8. Punch List Completion	7 days
9. (Authorized start of Maintenance Period)	
10. Maintenance Completion	7 days

1.12 TEMPORARY UTILITIES

- A. Provide all temporary piping, wiring, meters, panels and other related appurtenances required between the source of supply and the point of use of utilities, or as required for medical center and/or renovation projects.
 - 1. Permission to shut off in-use utilities must be obtained 48 hours in advance or as required for Medical Center and/or renovation projects, in writing from the College's Representative. The College's Representative shall determine the length of time for each shut-off.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Plants shall be in accordance with the California State Regulations for Nursery Inspection of Rules and Grading. All plants shall have a normal habit of growth and shall be sound, healthy and vigorous.
- B. Soil Amendments: An assumed median level of amendments, including Gypsum, Soil Sulfur, Iron Sulfate and Organic Soil Amendment, must be specified for bidding purposes and adjusted as a result of final soil analysis during construction.
- C. Fertilizing: All planting areas shall be fertilized. Incorporate fertilizer with soil amendments based on soil analysis.



2.2 TURFGRASS SOD

- A. Sod shall be in Play Fields shall be reviewed and approved by District Representative during Design Phase, Submittal Phase and Pre-Installation Phase of project. Sod for areas not to be Play Fields shall be Tall Fescue. Contractor shall verify with the supplier, that the sod type and quantity will be available at time of installation. Substitution will not be considered after acceptance of submittals.
- B. Sod shall be machine cut at a uniform soil thickness of 5/8 inch plus or minus 1/4 inch. Measurements for thickness shall exclude top growth and thatch. Individual pieces of sod shall be cut to the supplier's standard width and length. Maximum allowable deviation from standard width and lengths shall be 2 percent. Broken rolls or slabs and torn or uneven ends will not be acceptable. Standard size sections of sod shall be strong enough to support their own weight and retain their size and shape when suspended vertically from a firm grasp on the upper 10 percent of the section.
- C. Sod shall be harvested, delivered and installed within a period of 24 hours, unless a suitable preservation method is approved prior to delivery. Sod not installed within this period shall be reviewed prior to installation and accepted by the Architect. Sod shall not be harvested or transplanted when moisture content may adversely affect handling and installation.

2.3 INORGANIC SOIL AMENDMENTS

- A. Soil Sulfur: A commercially processed and packaged product in elemental form (S) Sulfur 90%, capable of oxidizing over time and providing nutrient sulfur. Pelletized.
- B. Iron Sulfate: A non-staining iron with micronutrients, pelletized, slow release, environmentally safe, 40% Iron, 1% Manganese, 1% Zinc, 1% Magnesium, 6% Sulfur, 2% Humic Acids..
- C. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate. Ninety percent shall pass a 50 mesh screen.

2.4 SOIL AMENDMENTS

- A. Soil Amendment/Conditioner: An organic, sustainably sourced product made from plant trimmings supplying slow release primary minerals of Nitrogen, Phosphate, Potash. Shall not contain poultry, animal or human waste. Finished product screened through 3/8" mesh and have a moisture content of 25%. "Humic Compost" by Agri Service (800) 262-4167.
- B. Iron Sulfate: a commercially processed and packaged product (FeSO4 H2O) Ferrous Sulphate Monohydrate - 95.7%. Ninety percent passing a 50 mesh screen. (Per soils lab analysis).
- C. Sulfur: a commercially processed and packaged product in elemental form (S) Sulfur - 95.0%, capable of oxidizing over time and providing nutrient sulfur. Pelletized. (Per soils lab analysis).

2.5 FERTILIZER

- A. Pre-plant Fertilizer: Starter Fertilizer for lawns and grasses with an analysis of 6-20-20swith Soil Penetrant Added. Fertilizer and soil conditioner derived from organic materials consisting of higher plant form life, composted beyond the fibrous stage. Shall not contain any of the following: poultry, animal or human waste, pathogenic viruses, fly larvae, insecticides, herbicides, fungicides or poisonous chemicals that would inhibit plant growth. Physical properties: A uniform "Beaded" homogenous mixture - 100.00% passing through a #4 mesh screen - a water soluble bio-degradable binder is used to insure fast breakdown. Such as "Gro-Power Plus 5-3-1" as manufactured by Gro-Power®, Inc. (909)393-3744, or approved equal Chemical Analysis: 8-2-4, nitrogen 8.00%, phosphate 2.00%, soluble potash 4.00%, Calcium

Nitrogen	5%	minimum
Phosphoric Acid	3%	minimum
Water Soluble Potash	1%	minimum
Humus	70%	minimum
Humic Acids	5%	minimum
Soluble Metallic Iron	1%	minimum
Soil Penetrant: (Alkyl Naphthalene Sodium Sulfonate)		



1% minimum

Bacterial "stimulator":
(Common soil and airborne organisms - aerobic, anaerobic, yeast and mold)
60,000 per 100-gram minimum

- B. Post-plant Fertilizer: Controlled release blend of methylene ureas, phosphorus, Potash and trace minerals. Humus and humic acids are added to aid the plant to assimilate necessary nutrients. Not dependent on bacterial breakdown. As manufactured by Gro-Power®, Inc. (909)393-3744, no known equal.

Chemical analysis: 12-8-8, nitrogen 12.00%, phosphate 8.00%, soluble potash 8.00%, calcium

Nitrogen	12%	minimum
Phosphoric acid	8%	minimum
Soluble potash	8%	minimum

- C. Soil Conditioner plus Calcium: JTM Nutrients 'Activator Ca' Fertilizer and soil conditioner derived from magnetic rock, and rock phosphate. 10% Humic acid as derived from humic shale ore. Shall not contain poultry, animal or human waste. As manufactured by JTM Nutrients® (949) 632-7378, no known equal.

- D. Chemical Analysis: 0-5.5-0 (7%) Ca, phosphate 4.00%, Calcium 7.00%, Iron 1.00%.

Phosphate	4%	minimum
Calcium	7%	minimum
Iron	1%	minimum

- E. Soil Conditioner: Mycorrhizal Inoculum / Soil Conditioner: Inoculum shall be both Endo and Ecto (granular), with consisting of propagules (spores, fragments of fungal mycelium, and pieces of mycorrhizal roots capable of colonizing host plant roots) of the vesicular arbuscular mycorrhizal species *Glomus intraradices*, *Glomus aggregatum*, *Glomus mosseae*, combined with other species and/or additional genera including, *Sclerocystis*, *Gigaspora*, *Scutellospora*, *Entrophospora*, and *Acaulospora*. Ectomycorrhiza include *Pisolithus* and 4 species of *Rhizopogon*. Soil Conditioner portion shall consist of organic materials consisting of higher plant form life, composted beyond the fibrous stage, to humus. Also shall have humic acids and beneficial soil bacteria strains. It shall NOT contain poultry, animal or human waste (i.e., sewage sludge), pathogenic viruses, fly larvae, insecticides, herbicides, fungicide or poisonous chemicals that would inhibit plant growth. Shall be "GroLife" (800) 473-1307, to match existing. This is a necessary item, that is only available from the listed source, and no other product shall be furnished.

<u>Ingredients</u>	<u>percentage (minimum)</u>
--------------------	-----------------------------

- | | |
|-------------------------|----------------------------------|
| 1. Mycorrhizal Inoculum | 6,500/55,000 propagules per lb.* |
| 2. Humus | 65% |
| 3. Humic Acid | 25% |

2.6 BARRICADE MATERIALS

- A. Protective Enclosure: "Temporary" construction fence 6' tall chain link fence with a minimum 1½" dia. posts and 1" top and bottom rails.
- B. 36" high orange snow fence w/ metal stakes or approved equal.
- C. Caution tape, or twine and flags are not acceptable.

2.7 MISCELLANEOUS PRODUCTS

- A. Prior to using herbicides, contractor shall review procedures with the College's Representative and obtain written approval. A contractor licensed by the department of Pesticide Regulation (DPR) with an active Qualified Applicator's Certificate (QAC) or a Qualified Applicator's License (QAL) only shall perform herbicide applications. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.



- B. Pre-emergent herbicide shall be Treflan, Surfland, Eptan, or equal.

2.8 SPORT FIELD SOIL MIX (review with University prior to final specification)

- A. Sport Field Mix –available from Gail Materials (951) 667-6106. Shall be a loamy sand based on the USDA soil classification system. The silt clay ration shall be in the range of .5 -1. Allowable gravel fraction shall not exceed 10% with maximum gravel size not exceeding ¼". The PH ration shall be in a range of 6.0-7.5 and salinity shall not exceed 3.0 dS/m and the SAR shall not exceed 5. The loamy sand shall be uniformly amended as follows:

AMOUNT / CUBIC YARD

- 15% by volume Organic soil amendment
- 10% by volume AXIS
- 2lbs Pre-Plant Fertilizer: JTM Nutrients 'Complete'
- 1lb Gypsum

PART 3 - EXECUTION

3.1 GENERAL

- A. Finish Grading: All grades shall be finished graded. Finish grades shall be coordinated with adjacent finish paving and finish surfaces.
- B. Rototilling/ripping: Rip, recompact and amend native subgrade to a depth of 18 inches prior to placement of import sports field mix and/or amendments. Remove all rocks in the top 6 inches of amended subgrade. Mitigate compaction in planting areas due to staging or construction.

3.2 EXAMINATION

- A. Examine areas to receive sod and seeding for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine areas to be planted before start of work, locate utilities, improvements, and easements, verify dimensions and areas shown on the Drawings with actual conditions identify and tag existing plant material to remain. Document conditions, which are in, direct conflict with the Drawings and notify the College's Representative. Do not start work until conditions that would adversely affect performance, installation, or quality of the work have been corrected. Start of work of this Section constitutes acceptance of the conditions.

3.3 WEED CONTROL

- A. Prior to commencement of the planting operations, remove all weeds including the roots, remove existing plant material including stumps designated not to remain, dispose of cleared and grubbed material at a legal refuse site. Prior to using herbicides, review procedures with the Owner Representative, and obtain written approval. An operator licensed by the Department of pesticide Regulation (DPR) with an active Qualified Applicator's Certificate (QAC) or a Qualified Applicator's License (QAL) shall perform herbicide applications requiring government or agency approvals. Protect existing plant material on site and on adjacent properties from exposure to herbicides and equipment. Erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.4 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.5 SOIL PREPARATION

- A. Limit lawn and seeding preparation to areas to be planted.



- B. Newly Graded Subgrades: Loosen existing subgrade to a minimum depth of 18 inches without adding soil conditioner. Remove stones, clods and debris larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off College's property provide positive drainage of subgrade prior to installation of sport field soil mix.
1. Spread soil conditioner, gypsum and other amendments over all planting areas indicated on the Drawings, and mechanically till and blend to a depth of 6 inches.
 2. Rake smooth, lightly water, and compact to the finish grades shown on the Drawings. Use the amendments listed below for bidding purposes only. Materials and application rates may be modified after receipt of soils tests.
 3. Use the amendments listed below for bidding purposes only. Modify materials and application rates after receipt of soils tests.

a. Soil Conditioner	6 cy./ 1000 sq.ft
b. Gypsum	100 lbs./ 1000 sq.ft.
c. Pre-Plant Fertilizer 5-3-1/	150 lbs./ 1000 sq.ft
d. Soil Sulfur	10 lbs./ 1000 sq.ft
e. Mycorrhizal Inoculum / Soil Conditioner	20 lbs./ 1000 sq.ft
 4. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 5. Thoroughly blend planting soil mix off-site before spreading, apply soil amendments on surface, and thoroughly blend planting soil mix.
 6. Spread import sport field soil mix to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is, muddy, or excessively wet.
 - a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil mix.
 - b. Rake smooth and roll the area to compact and expose soil depressions or surface irregularities. Re-grade as necessary to achieve the finish grades indicated on the Drawings less the depth of the sod.
- C. For Turfgrass only: Irrigate the area to thoroughly moisten soil and evenly broadcast the turf fertilizer (16-20-0) at the rate of one pound per 100 square feet, rake in lightly to a depth of 1".
1. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 2. Remove stones larger than 1-inch in any dimension and sticks, roots, trash, and other extraneous matter.
 3. Legally dispose of waste material, including grass, vegetation, and turf, off College's property.
 4. Rake smooth and roll the area to compact and expose soil depressions or surface irregularities. Re-grade as necessary to achieve the finish grades indicated on the Drawings less the depth of the sod.
 5. Irrigate the area to thoroughly moisten soil and evenly broadcast the turf fertilizer (16-20-0) at the rate of one pound per 100 square feet, rake in lightly to a depth of 1".
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Float smooth and compact all soil preparation areas to 85% relative dry density, maintain positive drainage, flow lines, and swells to area drains, fine grade to within plus or minus 0.10 foot of the grades shown on the Drawings. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.
- E. Moisten prepared lawn and seeding areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.6 TURFGRASS SOD INSTALLATION

- A. Soil Preparation -Rake smooth and roll the area to compact and expose soil depressions or surface irregularities. Re-grade as necessary to achieve the finish grades indicated on the Drawings less



the depth of the sod. Irrigate the area to thoroughly moisten soil and evenly broadcast the turf fertilizer (16-20-0) at the rate of one pound per 100 square feet, rake in lightly to a depth of 1".

- B. Installation: Place the first row of sod along a straight line. Butt joints tightly, do not overlap edges, and stagger the joints of succeeding rows. Use a sharp knife to cut the sod to fit curves, edges, around sprinkler heads, and other appurtenances. Water-in large areas to prevent drying, and continue to lay sod until installation is complete. After laying all sod, roll lightly to eliminate irregularities, and to form good contact between the sod and soil.

3.7 IRRIGATION

- A. Irrigate areas throughout the construction and maintenance period, or until the planting is sufficiently well established as per College's Representative's approval.

3.8 SATISFACTORY LAWNS

- A. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.

3.9 CLEANUP AND PROTECTION

- A. As the work progresses, maintain areas in a neat, clean, orderly manner, and remove unsightly debris as necessary. At the completion of the work, sweep and clean all walks, parking and other paved areas adjacent to plantings.
- B. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- C. Protect plants, lawns from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged exterior planting.
- D. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.
- E. Remove erosion-control measures after grass establishment period.

3.10 DISPOSAL

- A. Disposal: All grubbed material, rock, surplus soil and waste material, including excess subsoil, unsuitable soil, trash and other debris shall be removed from the College's property and disposed of in a legal disposal or recycling site.

3.11 MAINTENANCE

- A. Maintenance of turf areas includes proper watering and soil moisture content, fertilizing, mulching, cutting, rolling, pest and disease control, reseeding and other functions necessary to maintain a healthy, vigorous growing lawn. Maintenance will continue until all lawn areas have a complete established close stand of grass.
- B. Maintenance Schedules: Provide complete maintenance specifications including general design maintenance intent of plant material and fertilizing schedule based on planting design.

END OF SECTION 32 93 13

**SECTION 32 93 16
EXTERIOR PLANTS**

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Section Includes complete installation of landscape items as shown on the Drawings and as specified in this Section
- B. Related Sections
 - 1. 01 56 39 - Tree and Plant Protection
 - 2. 03 30 00 - Cast-in-place Concrete
 - 3. 03 33 10 - Landscape Site Concrete Walls
 - 4. 12 93 00 - Site Furnishings
 - 5. 31 10 00 - Site Clearing
 - 6. 31 22 00 - Grading
 - 7. 31 23 16 - Excavation
 - 8. 31 23 23 - Fill: Compacted Subbase for Paving
 - 9. 32 12 16 - Asphalt Paving
 - 10. 32 12 17 - Decomposed Granite Paving
 - 11. 32 13 13 - Concrete Paving
 - 12. 32 13 16 - Decorative Concrete Paving
 - 13. 32 14 13 - Unit Paving
 - 14. 32 84 00 - Landscape Irrigation
 - 15. 32 93 13 - Lawns and Grasses
 - 16. 32 93 16 - Exterior Plants
 - 17. 33 41 11 - Storm Utility Drainage Piping

1.2 GENERAL REQUIREMENTS/DEFINITIONS

- A. The term "Planting Area" shall mean areas to be planted with trees, shrubs, groundcovers, lawn, or seed, or areas to be covered with various gravel or stone mulches not intended for pedestrian or vehicular circulation.
- B. The term "Contract Close-out" shall mean the date at the close of the Maintenance Period when the work has been completed, checked, accepted, and written approval of the work has been given by the College's Representative.
- C. The term "Date of Acceptance" shall mean the date at the end of the warranty periods as specified herein, and written acceptance has been given by the College's Representative.
- D. Protect and maintain at all times the existing plant material identified on the Drawings as "to remain".
- E. Finish Grade: Elevation of finished surface of planting soil.
- F. Import Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- G. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.
- H. Planter Pot Soil/Interior Plant Medium: Soil produced by blending a mixture of organics, sand and nutrients to be used as a growing medium for plants in pots located interior or exterior.
- I. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.
- J. Raised Planter: Planted areas that are bounded by any (1) wall 12" higher than adjacent grade or surface. To be filled with import topsoil to the full and complete depth of the planter.



1.3 SUBMITTALS

- A. Submittals for above items shall be made in one package. If submittals are judged incomplete or non-responsive to the directions of the College's Representative after three (3) submissions the Contractor shall be back charged for the College's Representatives costs to process additional Submittals. Additional Submittal Procedures are specified in Section 01 33 00.
- B. Product Data and Samples:
 - 1. Soil amendments and fertilizers: Submit manufacturer's product data on amendments and fertilizers as noted. Include brand names, estimated quantities, and supplier.
 - 2. Plant materials: Submit a list of all plant materials with quantities, sizes, and source.
 - 3. Trees: For each species, submit three (3) colored photographs with botanical name, container size, height, spread, and nursery source on the back of each photo. Include an adult human figure in each photograph for scale.
 - a. Palm Trees: Submit photos as noted above. Submit documentation from the nursery certifying the trees have been inspected by a county or state agricultural agency, the trees are disease and pest free, and are available for sale.
 - 4. Bark Mulches: Submit three (3) 1/4 lb. bagged samples of each specified material. Label bag with name, source, size, and color range.
 - 5. Decomposed Granite and Rock Mulch 3/4" to 1" -2" diameter: Submit three (3) 1 lb. bagged samples of each specified material. Label bag with: name, source, size, and color range.
 - 6. Landscape products: Submit manufacturer's product data for all landscape products specified below.
- C. Soil Analysis: Soil analysis test reports shall be completed after rough grading to determine actual recommended soil amendments. Refer to Part 1: SOIL TESTING. Provide soil testing laboratory a copy of the 32 93 16 Exterior Plants Specification and Plant List with soil samples. Maintenance Instructions: Prepare instructions for maintenance in cooperation with the Owner for the Maintenance of exterior plants during a calendar year. Submit before expiration of required maintenance periods. Instructions shall include but not be limited to the following tasks:
 - 1. Fertilizing
 - 2. Irrigation schedule
 - 3. Dead heading
 - 4. Mulch or other inert groundcover replenishment
 - 5. Pruning of Shrubs to maintain design intent
 - 6. 3 year tree maintenance schedule
- D. As Built Drawings of Landscape Planting.

1.4 QUALITY ASSURANCE

- A. Reference Standards: Reference Standards apply to this Sections and shall be the latest edition of the following:
 - 1. "A Checklist of Woody Ornamental Plants of California", Owner of California, College of Agriculture
 - 2. ANSI Z60.1 American Standards for Nursery Stock
 - 3. "Seed Laws" State of California Department of Food and Agriculture
 - 4. "Seed Laws" U.S. Department of Agriculture
 - 5. Hortus Third
 - 6. Sunset Western Garden Book, Sunset Publishing Corporation
- B. Landscaping Contractor
 - 1. Installer Qualifications: All of the work required to be provided as described in this Section of the Specifications shall be provided by a sub-contractor skilled in this specialty, holding a valid C-27 California contractor's license.
 - 2. The qualified landscape installer shall exhibit work that has resulted in exterior plants establishment. Submitted qualifications shall include a client list with contact names, phone



numbers and date exterior planting was installed. Submitted qualifications shall include a client list with contact names, phone numbers and date California Native Plant Landscapes were installed.

3. All work shall be performed by a trained crew in accordance with the standards and practices related to the trade.
4. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when exterior planting is in progress.
5. This full-time supervisor must possess a current Certified Landscape Technician (CLT) certificate with the California Landscape Contractors Association (CLCA), and is to be present at all times during execution of this portion of the work and who is thoroughly familiar with the methods of installation and who is to direct all work performed under this section.
6. Provide photocopies of the current CLT registration for all foreman performing work on this project.

1.5 WARRANTY AND REPLACEMENTS

- A. Submit written warranties on the Contractor's or subcontractor's letterhead, addressed to the Owner. Submit all warranties in duplicate and in the form shown in the General Conditions, or modified as approved to suit the conditions pertaining to the warranty.
- B. Trees shall be warranted to remain healthy and in a vigorous growing condition for a period of one year from Contract Close-out.
- C. Shrubs, vines and groundcovers shall be warranted to remain healthy and in a vigorous growing condition for a period of six months from Contract Close-out.
- D. Palm trees shall be warranted to remain healthy and in a vigorous growing condition for a period of two years from Contract Close-out.
- E. Plants found dead or not in a vigorous growing condition during the Warranty Period shall be removed and replaced within 14 days of written notification by the College's Representative. Replacement plants shall be of the same size, species and variety as specified. Replacement includes restoration of surrounding area to match the existing conditions. All work shall be provided at no additional expense to the Owner.

1.6 REJECTION AND SUBSTITUTION

- A. Products or materials, whether installed or not, not conforming to the requirements herein specified shall be considered defective, and be marked as rejected. Materials shall be removed and replaced with approved materials at no additional cost to the Owner.
- B. Submit written request for each proposed substitution. Provide data substantiating request as well as a "Certificate of Suitability" certifying that the proposed substitution is equal or better in all respects to that specified and that it will, in all respects perform the function for which it is intended. Include with request all required samples. Submit 3 copies of all written requests and data for proposed substitution.

1.7 SITE OBSERVATIONS

- A. Schedule and coordinate site observation visits for the following construction activities. Reviews shall be performed by the College's Representative and notification shall be given in advance as noted:

<u>Item</u>	<u>Advance Notice</u>	
1. Protection of existing plant materials	48	hours
2. Rough grade and soil tests	48	hours
3. Plant material	48	hours
4. Soil preparation and finish grade	48	hours
5. Percolation tests	48	hours
6. Plant layout and installation	48	hours



- 7. Substantial Completion Punch List 7 days
- 8. Punch List Completion 7 days
(Authorize start of Maintenance Period)
- 9. Maintenance Completion 7 days

B. Site observations and acceptance will be documented in writing by the College's Representative. No site observations shall commence without items noted in previous reports being completed, remedied, or waived by the Owner. If Contractor is not prepared for a scheduled site observation the Contractor shall be back charged for the costs incurred by the College's Representative.

1.8 MAINTENANCE

- A. The Maintenance Period begins on the first day after all work has been reviewed and accepted in writing by the College's Representative. The College's Representative shall determine the start date, and the Period shall continue thereafter for 90 continuous calendar days.
- B. Within one week of receipt of the written notice, submit a Maintenance Schedule to the College's Representative listing the days when maintenance crews will be on site, include in the schedule, a contact person and emergency phone number.
- C. Maintenance includes weeding, watering, fertilizing, pruning, trimming, mowing, pest and disease control, water monitoring, re-staking/ guying, mulching, clean-up and other operations required to establish a healthy growing condition.
- D. The Maintenance Period shall be extended, when in the opinion of the College's Representative, dead or dying plant materials, poor or unhealthy growing conditions, or improper maintenance practices are evident at the close of the Period. The extended period shall be provided at no additional cost to the Owner, and shall be extended until the work is complete and acceptable to the College's Representative.

1.9 TEMPORARY UTILITIES

- A. Provide all temporary piping, wiring, meters, panels and other related appurtenances required between the source of supply and the point of use of utilities.
- B. Permission to shut off in-use utilities must be obtained 48 hours in advance, in writing from the College's Representative. The College's Representative shall determine the length of time for each shut-off.

1.10 SOIL TESTING

- A. Qualifications
 - 1. Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- B. Supply Soil Testing Laboratory with complete copy of 32 93 16 Specification Section and Plant List at time of soil tests. Soil amendment recommendations from soil laboratory shall be based on the submitted products in this specification when possible.
- C. Soil Testing After Rough Grading
 - 1. At the conclusion of rough grading, collect soil samples per planting plan with key map indicating soil sample number, and submit the samples to an agricultural soils laboratory for testing. Submit the test results to the College's Representative for review. No amendments shall be applied prior to receipt of test results. The College's Representative shall recommend changes to the amendments and/or procedure listed herein, after review of the test results. Costs for testing shall be included in the base bid. Cost change for soil preparation work shall be in accordance with the provisions of the General Conditions.
 - 2. A soil analysis shall be made after rough grading operations are complete to determine actual recommended soil amendments.

3. Soil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter, textural test, textural classification, silt sand clay content; sodium absorption rate (SAR), electrical conductivity (ECe), cation exchange capacity; boron content, deleterious material; pH; mineral and plant-nutrient content of topsoil and elemental data, corrective recommendations and soil amendment recommendations.
4. Report suitability of soil for plant growth. State recommended quantities of amendments and soil amendments to be added to produce satisfactory planting soil. Testing agency must use amendments listed in this specification in their recommendations.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Label each plant group with full botanical name, species, and varieties on weatherproof tags attached securely to the plant before delivery to the site. Provide a minimum of one labeled plant for each five (5) plants in a group.
- B. Plants shall have a normal growth habit, be sound, healthy, vigorous and free from insect pests, insect eggs, plant diseases, sun scalds, fresh bark abrasions, excessive disfigurements, and meet or exceed the measurements specified. Trunks shall be sturdy and well "hardened-off". Plants shall have normal well-developed, vigorous and fibrous root systems which are neither root, nor container-bound, are free of kinked or girdling roots. Plants shall have grown in their containers for at least six months, but not over two years. Plants that have cracked or broken rootballs shall be replaced with the same species, size, and character as specified.
- C. Groundcover plants shall be healthy vigorous rooted cuttings grown in flats for at least three months, but not over six months.
- D. Succulents: Shall be acquired from a licensed nursery. Provide the nursery suppliers to the College's Representative. Succulents shall be free of insects, mottled leaves, broken or split branches or trunks, scarring or any other uncharacteristic growth patterns.
- E. Obtain inspections, and secure permits or certificates required by City, County, or State authorities prior to delivery to the site. No plant material may be delivered to the site that is located within a Department of Agriculture quarantined zone.
- F. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, stunted and disfigurement. Plants shall have normal well-developed, vigorous and fibrous root systems which are neither root, nor container-bound, are free of kinked or girdling roots.
- G. Grade: Provide trees and shrubs of sizes and grades complying with ANSI Z60.1 for type of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to College's Representative, with a proportionate increase in size of roots or balls.

2.2 TREE AND SHRUB MATERIAL

- A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, stunted and disfigurement. Plants shall have normal well-developed, vigorous and fibrous root systems which are neither root, nor container-bound, are free of kinked or girdling roots. Trunk caliper and taper shall be sufficient so that the lower five feet of the trunk remains vertical without a stake. Auxiliary stake may be used to maintain a straight leader in the upper half of the tree.
- B. Grade: Provide trees and shrubs of sizes and grades complying with ANSI Z60.1 for type of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to College's Representative, with a proportionate increase in size of roots or balls.
- C. Label at least five trees and five shrubs of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.



- D. In formal arrangements, if matching specimens are indicated or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.
- E. Obtain inspections, and secure permits or certificates required by authorities having jurisdiction prior to delivery.

2.3 TREES / PALM TREES

- A. Typical Distinctions are Standard, Natural Form, Multi-stem.
- B. Standard Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height, width and caliper indicated, complying with ANSI Z60.1 for type of trees required.
- C. Natural Form Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, width and branching according to ANSI Z60.1.
- D. Multi-stem Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, width and branching according to ANSI Z60.1. Multi-stem trees shall be naturally occurring as multi-stem trees. Nursery created multi-stem trees are not acceptable.
- E. Trees shall be grown under climatic conditions similar to the conditions of the project site. Take care to prevent scarring, marking or injury to the trunks during delivery and installation.
- F. Palm Trees shall be grown under climatic conditions similar to the conditions of the project site. Including full sun exposure. Take care to prevent scarring, marking or injury to the trunks and terminal bud/crown during delivery and installation. Prior to delivery remove dead fronds lower than 5' from the crown and "bundle and tie" the remaining fronds over the crown with hemp rope. Field grown trees shall have the root balls "balled and burlapped" prior to delivery.

2.4 DECIDUOUS SHRUBS

- A. Form and Size: Deciduous shrubs with not less than the minimum height and spread specified in the drawings or required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.

2.5 CALIFORNIA NATIVE PLANTING

- A. Form and Size: California Native Planting with not less than the minimum height and spread specified in the drawings or required by and measured according to ANSI Z60.1 for type, shape, and height of California Native Planting.

2.6 GROUND COVER PLANTS

- A. Ground Cover: Provide ground cover of species indicated, established and well rooted in flats, pots or similar containers, and complying with ANSI Z60.1
- B. Groundcover plants shall be healthy vigorous rooted cuttings grown in containers for at least three months, but not over six months.

2.7 SOIL AMENDMENT AND FERTILIZER

- A. Organic Soil Amendment/Conditioner: An organic, sustainably sourced product made from plant trimmings supplying slow release primary minerals of Nitrogen, Phosphate, Potash. Shall not contain poultry, animal or human waste. Finished product screened through 3/8" mesh and have a moisture content of 25%. "Humic Compost" by Agri Service (800) 262-4167.
- B. Gypsum: a commercially processed and packaged gypsum (CaSo₄, H₂O) Calcium Sulfate Product - 94.3%. Ninety percent shall pass a 50 mesh screen.
- C. Iron Sulfate: a commercially processed and packaged product (FeSO₄ H₂O) Ferrous Sulphate Monohydrate - 95.7%. Ninety percent passing a 50 mesh screen. (Per soils lab analysis).
- D. Sulfur: a commercially processed and packaged product in elemental form (S) Sulfur - 95.0%, capable of oxidizing over time and providing nutrient sulfur. Pelletized. (Per soils lab analysis).



- E. Pre-plant Fertilizer: Pre-plant Fertilizer for plants (5-3-1) with Soil Penetrant Added. Fertilizer and soil conditioner derived from organic materials consisting of higher plant form life, composted beyond the fibrous stage. Shall not contain any of the following: poultry, animal or human waste, pathogenic viruses, fly larvae, insecticides, herbicides, fungicides or poisonous chemicals that would inhibit plant growth. Physical properties: A uniform "Beaded" homogenous mixture - 100.00% passing through a #4 mesh screen - a water soluble bio-degradable binder is used to insure fast breakdown. Such as "Gro-Power Plus 5-3-1" as manufactured by Gro-Power®, Inc. (909)393-3744, or approved equal.

Nitrogen	5%	minimum
Phosphoric Acid	3%	minimum
Water Soluble Potash	1%	minimum
Humus	70%	minimum
Humic Acids	15%	minimum
Soluble Metallic Iron	1%	minimum
Soil Penetrant: (Alkyl Naphthalene Sodium Sulfonate)	1%	minimum
Bacterial "stimulator": (Common soil and airborne organisms - aerobic, anaerobic, yeast and mold)		60,000 per 100 gram minimum

- F. Post-plant Fertilizer: Controlled release blend of methylene ureas, phosphorus, Potash and trace minerals. Humus and humic acids are added to aid the plant to assimilate necessary nutrients. Not dependent on bacterial breakdown. As manufactured by Gro-Power®, Inc. (909)393-3744, no known equal.

Chemical analysis: 12-8-8, nitrogen 12.00%, phosphate 8.00%, soluble potash 8.00%, calcium

Nitrogen	12%	minimum
Phosphoric acid	8%	minimum
Soluble potash	8%	minimum

- G. Mineral Soil Conditioner plus Calcium: JTM Nutrients 'Activator Ca' Fertilizer and soil conditioner derived from magnetic rock, and rock phosphate. 10% humic acid as derived from humic shale ore. Shall not contain poultry, animal or human waste. As manufactured by JTM Nutrients® (949) 632-7378, no known equal.

Chemical Analysis: 0-5.5-0 (7%) Ca, phosphate 4.00%, Calcium 7.00%, Iron 1.00%.

Phosphate	4%	minimum
Calcium	7%	minimum
Iron	1%	minimum

- H. Mycorrhizal Soil Conditioner: Mycorrhizal Inoculum shall be both Endo and Ecto (granular), with consisting of propagules (spores, fragments of fungal mycelium, and pieces of mycorrhizal roots capable of colonizing host plant roots) of the vesicular arbuscular mycorrhizal species *Glomus intraradices*, *Glomus aggregatum*, *Glomus mosseae*, combined with other species and/or additional genera including, *Sclerocystis*, *Gigaspora*, *Scutellospora*, *Entrophospora*, and *Acaulospora*. Ectomycorrhiza include *Pisolithus* and 4 species of *Rhizopogon*. Soil Conditioner portion shall consist of organic materials consisting of higher plant form life, composted beyond the fibrous stage, to humus. Also shall have humic acids and beneficial soil bacteria strains. It shall NOT contain poultry, animal or human waste (i.e., sewage sludge), pathogenic viruses, fly larvae, insecticides, herbicides, fungicide or poisonous chemicals that would inhibit plant growth. Shall be "GroLife" As manufactured by GroPower (909)393-3744 – no known equal.



<u>Ingredients</u>	<u>percentage (minimum)</u>
Mycorrhizal Inoculum	6,500/55,000 propagules per lb.*
Humus	65%
Humic Acids	25%

I. Palm Fertilizer: Nontoxic concentrated Vitamin solution such as ‘Superthrive’ Vitamin Solution, as manufactured by Superthrive, (800) 441.8482.

J. Planting Tablets:

1. Tightly compressed chip type commercial grade planting tablets, and containing the following available percentages by weight of plant food, slow release fertilizer tablets, soil conditioner, and 24-month formulation with trace elements, composted organic higher plant form life and mineral matter. Shall not contain any poultry, animal or human waste. Such as “Gro-Power Planting Tablets (20-10-5)” as manufactured by Gro-Power®, Inc. (909)393-3744, no known equal:

Nitrogen	20%	minimum
Phosphoric Acid	10%	minimum
Potash	05%	minimum

2.8 BIORETENTION PLANTER SOIL (PROJECT SPECIFIC COORDINATE WITH CIVIL)

A. Bioretention planter soil mix of manufactured Loamy Sand per USDA Soil Classification Criteria, Well aged Humic Compost, and AXIS®. As manufactured by Gail Materials (951) 667-6106.

Upper Layer Mix Proportions: 75% Loamy Sand, 20% Humic Compost, 5% AXIS®

Lower Layer Mix Proportions: 95% Loamy Sand, 5% AXIS®.

2.9 IMPORT TOPSOIL

A. Provide soils test on proposed import soil for suitability review prior to delivery to the site.

B. Import topsoil to be supplied for the full depth of all raised planters; see Part 1 for definition of raised planters.

C. Import topsoil also to be used on-grade as required for fill operations or as specified in the drawings.

D. Silt plus clay content of the import soil shall not exceed 20% by weight with a minimum 95% passing the 2.0 millimeter sieve. The sodium absorption rate (SAR) shall not exceed 6 and the electrical conductivity (ECe) of the saturation extract of this soil shall not exceed 3.0 milliohms per centimeter at 25 degrees centigrade. The boron content shall be no greater than 1 part per million as measured on the saturation extract. Submit results of agricultural soils analysis for review and approval by the College’s Representative.

E. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 2 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

2.10 ON-STRUCTURE PLANTING MEDIUM

A. Add notes to see additional specs if using a proprietary mix based upon an on-structure system or add required type here based upon input from soils specialist.

2.11 GREENWALL PLANTING MEDIUM

A. Add notes to see additional specs if using a proprietary mix based upon an on-structure system or add required type here based upon input from soils specialist.



2.12 INTERIOR PLANTING MEDIUM

- A. Interior planting medium shall be a commercially blended interior growing medium consisting of Canadian Sphagnum peat moss, coarse perlite, starter nutrient charge (with Gypsum), and dolomitic limestone such as , Sunshine Mix #1 by Sun Gro Horticulture, 1(888)797.7328 or approved equal.

2.13 STAKING AND GUYING MATERIALS

- A. Wood stakes shall be lodge pole pine. Stakes shall not be treated with copper naphthenate. Stakes shall be straight shafts, shaved and cut clean and bare of branches and stubs, of uniform thickness with a minimum diameter of 2 inches, free of loose knots, splits or bends. Stakes for 24" box trees and smaller shall be no less than ten (10) feet in length. Stakes for 36" box trees and larger shall be no less than twelve (12) feet in length and 3" in diameter.
- B. Tree ties shall be flexible non-deteriorating self-fastening, UV coated black vinyl ties of sizes required to adequately support trees, "Century Universal Tree Tie, as supplied by Century Products, (714) 632.7083.
- C. Guying Materials: 3/16" braided steel cable, 6" open turnbuckles, 1/2" pvc pipe, Duckbill Anchors or 2 x 4 x 24" redwood deadman or approved equal.
- D. Vine Anchors and ties: Shall be silicone epoxy type, with wire clasp for vine.

2.14 MULCH

- A. Decomposed Granite Rock Mulch: 3/8" minus" screened "California Gold" crushed stone from Decorative Stone Solutions (800) 540-1147, or approved equal.- Stabilized at pathways
- B. Rock/Cobble: size" "Type/Name" cobble from Decorative Stone Solutions (800) 540-1147, or approved equal.
- C. Bark Mulch: (All planting except Native)Forest Fines, as supplied by Agri-Service and 760.214.1842. (Native Planting areas) Redwood Mulch

2.15 ACCESSORIES

- A. Tubes: 4" dia. SDR 35 perforated pipe cut to length as shown on the Drawings.
- B. Grates: 4" National Diversified Sales (NDS) #13S flat, round drain grates 'Sand' color in planting areas, dg, bark, rock or cobble mulch, #11 black in lawn or groundcover areas.
- C. Filter fabric "sock": Trevira Spunbond, Typar 3341, Geoscape Landscape Fabric - 2.5 oz., Commercial Grade", or approved equal.
- D. Root barrier shall be "Typar Biobarrier" root control root fabric with Treflan, manufactured by Dow Elanco., as supplied by Century Products., (714) 632.7083.
- E. Landscape fabric shall be "Typar 3301 Professional Landscape Fabric" manufactured by Dow Elanco, as supplied by John Deere Landscape (800) 347-4272.
 - 1. Unit Weight – 3.0 oz./Square yards
 - 2. Tensile Strength – 135 lbs.
 - 3. Color - Black

PART 3 - EXECUTION

3.1 GENERAL

- A. Rip and Re-compact: Rip and re-compact sub-grade in all on grade planting areas to a depth of 18 inches or as indicated in the Drawings prior to placement of amendments and prior to the installation of any irrigation lines. Remove all rocks in the top 6 inches. Mitigate compaction in planting areas due to staging or construction.
- B. Finish Grading: All grades shall be finished graded prior to the commencement of planting operations. Finish grades shall be coordinated with adjacent finish paving and finish surfaces.



3.2 EXAMINATION

- A. Examine areas to be planted before start of work, locate utilities, improvements, and easements, verify dimensions and areas shown on the Drawings with actual conditions, identify and tag existing plant material to remain. Document conditions which are in direct conflict with the Drawings and notify the College's Representative. Do not start work until conditions that would adversely affect performance, installation, or quality of the work has been corrected. Start of work of this Section constitutes acceptance of the conditions.

3.3 WEED CONTROL

- A. Prior to commencement of the planting operations, remove all weeds including the roots, remove existing plant material including stumps designated not to remain, dispose of cleared and grubbed material at a legal refuse site.
- B. Prior to using herbicides, review procedures with the College's Representative, and obtain written approval. Herbicide applications requiring government or agency approvals shall be performed by an operator licensed by the County.
- C. Protect existing plant material on site and on adjacent properties from exposure to herbicides and equipment.

3.4 SOILS TESTS

- A. At the conclusion of rough grading, collect soil samples as indicated on Drawings, and submit the samples to an agricultural soils laboratory for testing along with a copy of the 32 93 16 Exterior Plants Specification and a plant list. Soil amendment recommendations from soil laboratory shall be based on the submitted products in this specification when possible. Submit the test results to the College's Representative for review. No amendments shall be applied prior to receipt of test results. The College's Representative shall recommend changes to the amendments and/or procedure listed herein, after review of the test results. Costs for testing shall be included in the base bid. Cost change for soil preparation work shall be in accordance with the provisions of the General Conditions.

3.5 SOIL PREPARATION AND FINISH GRADES

- A. Spread amendments over all planting areas indicated on the Drawings, and mechanically till and blend to a depth of six (6) inches. Prepare areas within the dripline of existing trees by hand, do not use mechanical tillers. Remove foreign material, construction debris, and rocks larger than 2" in diameter. Rake smooth, lightly water, and compact to the finish grades shown on the Drawings. Use the amendments listed below for bidding purposes only. Materials and application rates may be modified after receipt of soils tests noted in item 3.04.

<u>Amendments</u>	<u>Rate or Quantity/1,000 s.f.</u>
1. Organic Soil Conditioner	4 cu. yds.
2. Nutrient Soil Conditioner plus Calcium	150 lbs.
3. Gypsum	10 lbs.
4. Soil Sulfur	10 lbs.
5. Pre-Plant Fertilizer	20 lbs.

- B. Float smooth and compact all soil preparation areas to 85% relative dry density, maintain positive drainage, flow lines, and swells to area drains, fine grade to within plus or minus 0.10 foot of the grades shown on the Drawings.

3.6 PERCOLATION TESTS

- A. Locate and prepare the percolation test pits where indicated on the Drawings (# locations), and as described herein.
- B. Excavate the pits as describe under the plant installation section, remove all loose material, and fill the pits with six inches (6") of water. After 12 hours refill with the same amount of water. Six hours



after the second filling, inspect the pits with the College's Representative and document locations where water remains in the pit.

- C. If percolation problems occur, provide means and methods for correcting said problems. Planting operations at the locations identified shall be suspended as necessary or as directed by the College's Representative. Payment for corrective work shall be in accordance with the provisions of the General Conditions. Proceeding with the work without written approval, does not entitle the Contractor to additional compensation for corrective work.

3.7 TREE AND SHRUB PLANTING

- A. Tree Planting:
 - 1. Typical minimum distance from trees to building is 12 feet.
 - 2. Typical minimum distance from trees to walls or walks is 8 feet unless otherwise shown on plans.
 - 3. Tree root crown/flare should typically be slightly higher than surrounding finish grade.
 - 4. Do not plant trees over utilities, or typically closer than 10 feet.
 - 5. Dig holes for trees minimum 2 times greater than the diameter of the rootball. Keep plantings 18" away from valve boxes.
 - 6. Minimum tree planting cutout is 100 square feet.
 - 7. Create minimum 24 inch diameter mulched zone around trees within lawn area.
 - 8. Do not place mulch onto root crown/flare.
- B. Shrub Planting:
 - 1. Dig holes for shrubs and vines a minimum 3 times greater than the rootball.
 - 2. Typical minimum distance from shrub to edge of walks is one-half mature width. See Plant Legend for required offsets from paving.
- C. Placement: Center each tree, shrub or vine, set plumb, and hold rigidly in position until the planting backfill work is complete. Prior to backfilling, check for girdling or kinked roots, and correct the conditions according to accepted nursery practice. Set plants at a level that after settling results in the root crown to finish grade relationship shown on the Drawings and Details. Specimen plants in 36" box size or larger shall be placed, positioned, and set with a crane.
- D. Backfill and Compaction: Place backfill in maximum 6 inch layers. Compact to 85% relative dry density prior to placement of each succeeding layer in planting areas. At completion of the planting operation, thoroughly water-in each plant to the full depth of the plant pit. Use the amendments listed below for bidding purposes only. Materials and application rates may be modified after receipt of soils tests noted in item 3.04.
 - 1. Backfill mixture for all plants shall be thoroughly blended, consisting of the following:
 - a. Existing Soil 4 parts
 - b. Gypsum 25 lbs./CY of mix
 - c. Iron Sulfate 2 lbs./CY of mix
 - d. Soil Sulfur 1 lb./CY of mix
 - e. *Organic Soil Conditioner 15 lb./CY (Incorporate in only the top 18" layer.)
 - f. *Pre-plant Fertilizer (8-2-4) 30 lb./CY of mix (Incorporate in only the top 18" layer.)
 - g. **Mycorrhizal Soil Conditioner 10 lb./CY of mix
 - h. 'Superthrive' Vitamin Solution 2Tbsp/per 5 gal. water

3.8 CALIFORNIA NATIVE PLANTING

- A. Dig holes for California Native Planting a minimum 2 times greater than the rootball.
- B. Typical minimum distance from shrub to edge of walks is one-half mature width.
- C. Placement: Center each tree, shrub or vine, set plumb, and hold rigidly in position until the planting backfill work is complete. Prior to backfilling, check for girdling or kinked roots, and correct the



conditions according to accepted nursery practice. Set plants at a level that after settling results in the root crown to finish grade relationship shown on the Drawings. Specimen plants in 36" box size or larger shall be placed, positioned, and set with a crane.

- D. Backfill and Compaction: Place backfill in maximum 6 inch layers. Compact to 85% relative dry density prior to placement of each succeeding layer in planting areas. At completion of the planting operation, thoroughly water-in each plant to the full depth of the plant pit. Use the amendments listed below for bidding purposes only. Materials and application rates may be modified after receipt of soils tests noted in item 3.04.
 - 1. Backfill mixture for all California Native Plants shall be thoroughly blended, consisting of the following:
 - a. Existing Soil 4 parts
 - b. Organic Soil Conditioner 1 part
 - c. Mycorrhizal Inoculum / Soil Conditioner 10 lbs./ cu. yard of mix
 - d. Soil Conditioner plus Calcium 30 lbs./ cu. yard of mix

3.9 PALM INSTALLATION

- A. Delivery and Handling: Off-load and set all palms with a crane using a sling system designed for handling palms. Stockpile palms in an upright vertical position and protect the rootball from injury, drying, or cracking. Schedule deliveries, and crane time such that all bareroot palms are planted within 48 hours of delivery.
- B. Planting Pits: Excavate planting pits with vertical walls and level bottoms to the size and depth shown on the Drawings.
- C. Installation: Center palm in the pit, plumbed to true vertical from all directions and matched crown height. Align palms in the group in all directions. Adjust palms that may settle out of alignments during the construction, maintenance, and warranty periods.
- D. Pruning shall be done with reciprocal saws to prevent broadcast of any disease the tree may harbor. Chain saws will not be allowed. Saw blades shall be sterilized prior to beginning with 50% household bleach and 50% water for 10 minutes and shall be cleaned after each tree before proceeding to prune other trees
- E. All remaining fronds above horizontal shall be lifted up and tied together around the crown in an upright position. Due caution shall be taken not to bind or injure the crown.
- F. Backfill mixture for palm trees shall be thoroughly blended, consisting of the following:
 - 1. Washed Concrete Sand
 - 2. 'Superthrive' Vitamin Solution 2Tbsp/per 5 gal. water
 - 3. Mycorrhizal Inoculum / Soil Conditioner 5 lbs. / cu. yard of mix

3.10 GROUNDCOVERS INSTALLATION

- A. Prior to planting, check soil moisture for acceptable levels and lightly irrigate area as necessary, do not install plants in dry soil. Install plants in staggered rows and evenly spaced at the intervals indicated on the drawings. Excavate plant pits slightly larger than the rootball and place a 5 gram plant tablet in each pit, set plants to cover all roots, backfill, tamp, and rake area smooth.
- B. As each planting area is completed, thoroughly water-in the area to the full depth of planting pits.



3.11 PLANTING TABLETS

- A. Place planting tablets in all planting pits at the following rates:

<u>Plant Size</u>	<u>Quantity</u>	<u>Tablet Size</u>
Liner and flat size plant	1	5 gram
1 gallon container	1	21 gram
5 gallon container	2	21 gram
15 gallon container	3	21 gram
Box/Specimen	2	21 gram for each 12" of box size

3.12 AERATION TUBES

- A. Wrap tubes with the fabric and set plumb in opposite corners of the planting pit. Place gravel and backfill mix as shown on the Drawings. Cut tubes to 1" above finish grade and cap with a drain grate.

3.13 TREE AND VINE STAKING

- A. Tree Staking: Remove nursery stakes and ties. Single or double stake trees as noted and shown on the Drawings. Set stake on the side of the prevailing wind with the other stake (if double-staking) on the opposite side of the tree. Remove stakes at the end of the Warranty Period, or earlier if tree is self-supporting.
- B. Vine Staking: Remove nursery stakes or trellis from vines, and spread or "fan out" the branches in a symmetrical form against the adjacent walls, columns, fences, or structures. Allow main leader to remain in a horizontal fashion to encourage stems to bud. Attach the branches as necessary with vine ties. Use clear silicone to attach ties to masonry, concrete, or stucco, and 4d galvanized nails to wood fences.

3.14 POST-PLANT FERTILIZERS

- A. Controlled release fertilizers shall be applied according to the manufacturer's instructions and standard horticultural practices.

3.15 MULCH APPLICATION

- A. Gravel/D.G. Mulch: At the completion of the planting work, rake smooth the areas indicated on the Drawings, install landscape fabric and spread a 3" layer of gravel/D.G. over the areas, taper to adjacent paving.
- B. Bark Mulch: At the completion of the planting work, rake smooth the areas indicated on the Drawings, and spread a 3" layer of bark over the areas, taper to adjacent paving. Arrange mulch so as to not allow any visible grade showing.
- C. Lift all leaves, low hanging stems and other green portions of small plants out of mulch if covered.

3.16 ROOT BARRIER

- A. Root barrier shall be installed against hardscape features, or as shown diagrammatically on the Drawings, not encircling tree rootball. Install per manufacturer recommendations. Install RootBarrier where roots will have possibility of coming in contact with sidewalks, pathways and roadways. Determining factor shall within 5' from hardscape.

3.17 CLEAN-UP

- A. As the work progresses, maintain areas in a neat, clean, orderly manner, and remove unsightly debris as necessary. At the completion of the work, sweep and clean all walks, parking, and other paved areas adjacent to plantings.
- B. Remove and dispose of all tags, flagging materials are removed from plant material and accessories.



- C. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged exterior planting.

3.18 PROTECTION DURING CONSTRUCTION

- A. The Contractor shall protect planting and related work and other site work from damage due to planting operations, operations by other Contractors or trespassers. Maintain protection during installation until Substantial Completion Acceptance. Treat, repair or replace damaged work immediately.
- B. Damage done by the Contractor, or any of their sub-contractors to existing or installed plants, or any other parts of the work or existing features to remain, including roots, trunk or branches of large existing trees, soil, paving, utilities, lighting, irrigation, other finished work and surfaces including those on adjacent property, shall be cleaned, repaired or replaced by the Contractor at no expense to the Owner. The College's Representative shall determine when such cleaning, replacement or repair is satisfactory.

3.19 DISPOSAL

- A. Disposal: All grubbed material, rock, surplus soil and waste material, including excess subsoil, unsuitable soil, nursery pots and containers, tree boxes trash and other debris shall be removed from the College's property and disposed of or recycled in a legal disposal site.

3.20 SUBSTANTIAL COMPLETION ACCEPTANCE

- A. Upon written notice from the Contractor, the Owners Representative shall review the work and make a determination if the work is substantially complete.
 - 1. Notification shall be at least 7 days prior to the date the contractor is requesting the review.
- B. The date of substantial completion of the planting shall be the date when the College's Representative accept that all work in Planting, Planting Soil, and Irrigation installation sections is complete.
- C. The Plant Warranty period begins a date of written notification of substantial completion from the College's Representative. The date of substantial completion may be different than the date of substantial completion for the other sections of the project.

3.21 MAINTENANCE

- A. General Plant Material: During the warranty period, provide maintenance, every two weeks minimum, for all plantings to keep the plants in a healthy state and the planting areas clean and neat based upon plant design.
- B. General requirements:
 - 1. All work shall be undertaken by trained planting crews under the supervision of a foreman with a minimum of 5 years' experience supervising commercial plant maintenance crews.
 - 2. All chemical and fertilizer applications shall be made by licensed applicators for the type of chemicals to be used. All work and chemical use shall comply with all applicable local, provincial and federal requirements.
 - 3. Assure that hoses and watering equipment and other maintenance equipment does not block paths or be placed in a manner that may create tripping hazards. Use standard safety warning barriers and other procedures to maintain the site in a safe manner for visitors at all times.
 - 4. All workers shall wear required safety equipment and apparel appropriate for the tasks being undertaken.
 - 5. The Contractor shall not store maintenance equipment at the site at times when they are not in use unless authorized in writing by the College's Representative.
 - 6. Maintenance vehicles shall not park on the site including walks and lawn areas at any time without the College's Representative's written permission.
 - 7. All contractor vehicles shall have signed placard located on the dashboard when accessing campus interior.

8. Maintain a detailed log of all maintenance activities including types of tasks, date of task, types and quantities of materials and products used, watering times and amounts, and number of each crew. Periodically review the logs with the College's Representative, and submit a copy of the logs at the end of each year of the maintenance agreement.
 9. Meet with the College's Representative a minimum of three times a year to review the progress and discuss any changes that are needed in the maintenance program. At the end of the warranty period attend a hand over meeting to formally transfer the responsibilities of maintenance to the College's Representative. Provide all information on past maintenance activities and provide a list of critical tasks that will be needed over the next 12 months. Provide all maintenance logs and soil test data. Make the Contractor's supervisor available for a minimum of one year after the end of the warranty period to answer questions about past maintenance.
- C. Provide the following maintenance tasks:
1. Watering; Provide all water required to keep soil within and around the root balls at optimum moisture content for plant growth.
 - a. Maintain all watering systems and equipment and keep them operational.
 - b. Monitor soil moisture to provide sufficient water. Check soil moisture and root ball moisture with a soil moisture meter on a regular basis and record moisture readings. Do not over water.
 2. Soil nutrient levels: Take a minimum of 4 soil samples from around the site in the spring and fall and have them tested by an accredited agricultural soil testing lab for chemical composition of plant required nutrients, pH, salt and % organic matter. Test results shall include laboratory recommendations for nutrient applications. Apply fertilizers at rates recommended by the soil test.
 - a. Make any other soil test and/or plant tissue test that may be indicated by plant conditions that may not be related to soil nutrient levels such as soil contaminated by other chemicals or lack of chemical uptake by the plant.
 3. Plant pruning: Remove cross over branching, shorten or remove developing co dominant leaders, dead wood and winter-damaged branches. Unless directed by the College's Representative, do not shear plants or make heading cuts.
 4. Restore plants: Reset any plants that have settled or are leaning as soon as the condition is noticed.
 5. Guying and staking: Maintain plant guys in a taught position. Remove tree guys and staking after the first full growing season unless directed by College's Representative.
 6. Weed control: Keep all beds free of weeds. Hand-remove all weeds and any plants that do not appear on the planting plan. Chemical weed control is permitted only with the approval of the College's Representative. Schedule weeding as needed but not less *12 times per year*.
 7. Trash removal: Remove all trash and debris from all planting beds and maintain the beds in a neat and tidy appearance. The number of trash and debris removal visits shall be no less than 12 times per year and may coincide with other maintenance visits.
 8. Plant pest control: Maintain disease, insects and other pests at manageable levels. Manageable levels shall be defined as damage to plants that may be noticeable to a professional but not to the average person. Use least invasive methods to control plant disease and insect outbreaks.
 9. Plant replacement: Replace all plants that are defective as defined in the warranty provisions, as soon as the plant decline is obvious and in suitable weather and season for planting as outlined in above sections. Plants that become defective during the maintenance period shall be covered and replaced under the warranty provisions.
 10. Mulch: Refresh mulch once a year to maintain complete coverage but do not over mulch. At no time shall the overall mulch thickness be greater than 4 inches. Do not apply mulch within 6 inches of the trunks or stems of any plants. Replacement mulch shall meet the requirements



of the original approved material. Mulch shall be no more than one inch on top of the root ball surface.

11. Bed edging: Check and maintain edges between mulch and lawn areas in smooth neat lines as originally shown on the drawings.
12. Leaf, fruit and other plant debris removal: Remove fall leaf, spent flowers, fruit and plant part accumulations from beds and paved surfaces. Maintain all surface water drains free of debris. Debris removal shall be undertaken at each visit to weed or pick up trash in beds.
13. Damage from site use: Repair of damage by site visitors and events, beyond normal wear, are not part of this maintenance. The College's Representative may request that the Contractor repair damage beds or plantings for an additional cost. All additional work shall be approved in advance by the College's Representative.

3.22 END OF MAINTENANCE

- A. At the end of the Warranty and Maintenance period the College's Representative shall observe the work and establish that all provisions of the contract are complete and the work is satisfactory.
 1. If the work is satisfactory, the maintenance period will end on the date of the final observation.
 2. If the work is deemed unsatisfactory, the maintenance period will continue at no additional expense to the Owner until the work has been completed, observed, and approved by the College's Representative.
- B. FAILURE TO PASS OBSERVATION: If the work fails to pass final observation, any subsequent observations must be rescheduled as per above. The cost to the Owner for additional observations will be charged to the Contractor at the prevailing hourly rate of the Owners Representative.

END OF SECTION 32 93 16

SECTION 33 11 16
SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and fittings for site water lines including domestic water lines and fire water lines.

1.2 RELATED REQUIREMENTS

- A. Section 01 56 39 – Tree and Plant Protection
- B. Section 01 74 19 – Construction Waste Management and Disposal
- C. Section 03 30 00 - Cast-in-Place Concrete
- D. Section 21 11 00 – Facility Fire-Suppression Water-Service Piping
- E. Section 31 10 00 – Site Clearing
- F. Section 31 22 00 - Grading
- G. Section 31 23 16 – Excavation
- H. Section 31 23 23 - Fill
- I. Section 33 41 11 – Storm Drainage Utility Piping

1.3 REFERENCES

- A. ASME B16.3 - Malleable Iron Threaded Fittings Classes 150 and 300; 2011.
- B. ASME B16.4 - Gray Iron Threaded Fittings Classes 125 and 250; 2011.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2012 (ANSI B16.18).
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; The American Society of Mechanical Engineers; 2013.
- E. ASME B18.2.2 - Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series); 2010.
- F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- G. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2014.
- H. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts; 2007a (Reapproved 2014).
- I. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2014.
- J. ASTM D1785 - Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2015.
- K. ASTM D2241 - Standard Specification for Polyvinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series); 2009.
- L. ASTM D2466 - Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40; 2013.
- M. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with PolyVinyl Chloride (PVC) Pipe and Fittings; 1996 (Reapproved 2010).
- N. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals; 1998 (Reapproved 2011).
- O. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2011-AMD 1.



- P. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings; American Water Works Association; 2008 (ANSI/AWWA C104/A21.4).
- Q. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; American Water Works Association; 2010 (ANSI/AWWA C105/A21.5).
- R. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; American Water Works Association; 2012 (ANSI/AWWA C111/A21.11).
- S. AWWA C208 - Dimensions for Fabricated Steel Water Pipe Fittings; 2012 (ANSI/AWWA C208).
- T. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service; American Water Works Association; 2009 (ANSI/AWWA C509).
- U. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In. (100 mm through 300 mm), for Water Transmission and Distribution; American Water Works Association; 2007 (ANSI/AWWA C900/C900a).
- V. UL 246 - Hydrants for Fire-Protection Service; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner with minimal loss of service to owner.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with SSPWC requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers with labeling in place.

PART 2 - PRODUCTS

2.1 WATER PIPE

- A. Water Services: PVC Schedule 40, NSF Certified or Copper Tubing, ASTM B88, Type K, annealed:
 - 1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
 - 2. Joints: Compression connection or AWS A5.8M/A5.8, BCuP silver braze.
- B. Site Water Mains: PVC Pipe, AWWA C900, Class 200:
 - 1. Fittings: AWWA C111, cast iron.
 - 2. Joints: ASTM D3139 compression gasket ring.
 - 3. Couplings: Ford "Wide Range Couplings" or approved equal.

2.2 VALVES

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Gate Valves Up to 3 Inches:
 - 1. Brass or Bronze body, non-rising stem, inside screw, single wedge or disc,
 - 2. compression ends, with control rod, and extension box.
 - 3. Product: As indicated.

4. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Gate Valves 3 Inches and Over:
 1. AWWA C500, iron body, bronze trim, non-rising stem with square nut, single wedge, flanged ends, control rod, and extension box.
 2. flanged ends, control rod, and extension box.
 3. AWWA C509, iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, flanged ends, control rod, and extension box.
 4. Product: TBD.
 5. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in Section 31 23 23.
- B. Cover: As specified in Section 31 23 23.

2.4 ACCESSORIES

- A. Concrete for Thrust Restraints: Concrete type specified in Section 03 30 00.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.2 PREPARATION

- A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare pipe connections to equipment with flanges or unions.

3.3 TRENCHING

- A. See the sections on excavation and fill for additional requirements.
- B. Hand trim excavation for accurate placement of pipe to elevations indicated.
- C. Form and place concrete for pipe thrust restraints at each change of pipe direction. Place concrete to permit full access to pipe and pipe accessories. Provide thrust restraint bearing on subsoil.
- D. Backfill around sides and to top of pipe with cover fill, tamp in place and compact to specifications, then complete backfilling.

3.4 INSTALLATION - PIPE

- A. Maintain separation of water main from sewer piping in accordance with local and state codes.
- B. Group piping with other site piping work whenever practical.
- C. Establish elevations of buried piping to ensure not less than 3 feet of cover.
- D. Install pipe to indicated elevation to within tolerance of 5/8 inches.
- E. Install ductile iron piping and fittings to AWWA C600.
- F. Install grooved and shouldered pipe joints to AWWA C606.
- G. Route pipe in straight line.
- H. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- I. Install access fittings to permit disinfection of water system performed under Section 33 13 00.
- J. Slope water pipe and position drains at low points.
- K. Install trace wire 6 inches above top of pipe; coordinate with Section 31 23 23.
- L. Disinfect and test in accordance with AWWA requirements.



M. Remove and dispose of ACP pipe in accordance with regulations.

3.5 INSTALLATION - VALVES AND HYDRANTS

- A. Set valves on solid bearing.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade.
- C. Coat all exposed hardware with non-oxidizing grease and wrap with visqueen.

3.6 SERVICE CONNECTIONS

- A. Provide water service to utility company requirements.
- B. Connect water service at five feet from building wall, confirm location of shutoff valve.

3.7 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.
- B. Disinfect and pressure test water piping to 150 psi.
- C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

END OF SECTION 33 11 16



SECTION 33 31 11
SITE SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Sanitary sewerage piping, fittings, and accessories.
- B. Connection of building sanitary drainage system to municipal sewers; or campus sewer system.
- C. Cleanouts and manholes

1.2 RELATED REQUIREMENTS

- A. Section 01 56 39 – Tree and Plant Protection
- B. Section 01 74 19 – Construction Waste Management and Disposal
- C. Section 03 30 00 – Cast-in-Place Concrete
- D. Section 21 11 00 – Facility Fire-Suppression Water-Service Piping
- E. Section 31 10 00 – Site Clearing
- F. Section 31 22 00 - Grading
- G. Section 31 23 16 – Excavation
- H. Section 31 23 23 – Fill
- I. Section 33 11 16 – Site Water Utility Distribution Piping
- J. Section 33 41 11 – Storm Drainage Utility Piping

1.3 DEFINITIONS

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.4 REFERENCE STANDARDS

- A. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2012.
- B. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2011.
- C. ASTM D2729 - Standard Specification for Polyvinyl Chloride (PVC) Sewer Pipe and Fittings; 2011.
- D. ASTM D3034 - Standard Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings; 2014.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of sewer with size, location and installation of service utilities.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.6 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating pipe and pipe accessories.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- E. Field Quality Control Submittals: Document results of field quality control testing.
- F. Project Record Documents:
 - 1. Record location of pipe runs, laterals, cleanouts, manholes and invert elevations.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.



PART 2 - PRODUCTS

2.1 SEWER PIPE MATERIALS

- A. Provide products that comply with SSPWC.
- B. Plastic Pipe: ASTM D3034, Type PSM, Polyvinyl Chloride (PVC) material; inside nominal diameter as indicated, 4 inches minimum, bell and spigot style solvent sealed joint end.
- C. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.2 BEDDING AND COVER MATERIALS

- A. Pipe Bedding Material: As specified in Section 31 23 23.
- B. Pipe Cover Material: As specified in Section 31 23 23.

PART 3 - EXECUTION

3.1 GENERAL

- A. Perform work in accordance with SSPWC.

3.2 TRENCHING

- A. See Section 31 23 16 for additional requirements.
- B. Hand trim excavation for accurate placement of pipe to elevations indicated.
- C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.3 INSTALLATION - PIPE

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.
- B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 - 1. Plastic Pipe: Also comply with ASTM D2321.
- C. Lay pipe to slope gradients noted on drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
- D. Connect to building sanitary sewer outlet; municipal sewer system; or campus sewer system as shown.

3.4 INSTALLATION – CLEANOUTS AND MANHOLES

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete manhole base, with provision for sanitary sewer pipe connections.
- C. Establish elevations and pipe inverts for inlets and outlets as indicated.
- D. Mount lid and frame level in grout, secured to riser or top cone section to elevation indicated.

3.5 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
- C. Pressure Test: Test in accordance with SSPWC.
- D. Infiltration Test: Test in accordance with SSPWC.
- E. Deflection Test: Test in accordance with SSPWC.

3.6 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 33 31 11



SECTION 33 41 11
SITE STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Storm drainage piping, fittings, and accessories.
- B. Connection of drainage system to surface outlet or campus drainage system.
- C. Catch basins, curb inlets, trench drains, area drains and site surface drainage.

1.2 RELATED REQUIREMENTS

- A. Section 01 56 39 – Tree and Plant Protection
- B. Section 01 74 19 – Construction Waste Management and Disposal
- C. Section 03 30 00 - Cast-in-Place Concrete
- D. Section 31 10 00 – Site Clearing
- E. Section 31 22 00 - Grading
- F. Section 31 23 16 – Excavation
- G. Section 31 23 23 – Fill
- H. Section 32 12 16 – Asphalt Paving
- I. Section 32 12 17 – Decomposed Granite Paving
- J. Section 32 13 13 – Concrete Paving
- K. Section 32 14 13 – Unit Paving
- L. Section 33 11 16 – Site Water Utility Distribution Piping
- M. Section 33 41 11 – Storm Drainage Utility Piping

1.3 DEFINITIONS

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.4 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2003 (Reapproved 2012).
- C. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; 2014
- D. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2012.
- E. ASTM D2729 - Standard Specification for Polyvinyl Chloride (PVC) Sewer Pipe and Fittings; 2011.
- F. ASTM D3034 - Standard Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings; 2014.
- G. DIN EN 1433 - Drainage Channels for Vehicular and Pedestrian Areas - Classification, Design and Testing Requirements; Marking and Evaluation of Conformity; 2005.
- H. DIN 19580 - Drainage Channels for Vehicular and Pedestrian Areas - Durability, Mass per Unit Area and Evaluation of Conformity; 2010.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of drainage system with size, location and installation of service utilities.



- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner with minimal disruption.

1.6 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating pipe and pipe accessories.
- C. Manufacturer's Certificate: Certify that products meet or exceed SSPWC requirements.
- D. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- E. Field Quality Control Submittals: Document results of field quality control testing.
- F. Project Record Documents:
 - 1. Record location of pipe runs, connections, catch basins and invert elevations.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 REGULATORY REQUIREMENTS

- A. Conform to SSPWC code for materials and installation for the Work of this section.

PART 2 - PRODUCTS

2.1 DRAINAGE PIPE MATERIALS

- A. Provide products that comply with SSPWC code.
- B. Plastic Pipe: ASTM D3034, Type PSM, Polyvinyl Chloride (PVC) material; inside nominal diameter of 6 inches, bell and spigot style solvent sealed joint end.

2.2 PIPE ACCESSORIES

- A. Pipe Joints: Neoprene gasket for positive seal.
- B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.
- C. Filter Fabric: Non-biodegradable, non-woven, Mirafi 140N or approved equal.
- D. Downspout Boots: Smooth interior without boxed corners or choke points; include integral lug slots, integral cleanout, cleanout cover, and tamper proof fasteners.
 - 1. Configuration: 90 degree.
 - 2. Material: Cast iron; ASTM A48/A48.
 - 3. Finish: Manufacturer's standard factory applied powder coat finish.

2.3 CATCH BASIN, TRENCH DRAIN, CLEANOUT, AND AREA DRAIN COMPONENTS

- A. Lids and Drain Covers: Cast iron, hinged to cast iron frame.
 - 1. Catch Basin:
 - a. Lid Design: Checkerboard grill, ADA compliant.
 - b. Nominal Lid and Frame Size: 24 x 24 inch.
 - 2. Cleanout:
 - a. Lid Design: Solid.
 - b. Nominal Lid and Frame Size: 6 inch diameter.
 - 3. Area Drain:
 - a. Lid Design: Checkerboard grill, ADA compliant.
 - b. Nominal Lid and Frame Size: 6 inch diameter.
- B. Trench Drain System: Trench drain system assembled from factory fabricated, polymer concrete castings in standard lengths and variable depths, with integral joint flanges and integral grating support rails; includes joint gaskets and ADA compliant grating.

2.4 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in Section 31 23 23.



- B. Cover: As specified in Section 31 23 23.

PART 3 - EXECUTION

3.1 TRENCHING

- A. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.2 INSTALLATION - PIPE

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.
- B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 - 1. Plastic Pipe: Also comply with ASTM D2321.
- C. Lay pipe to slope gradients noted on drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
- D. Connect to building storm drainage system, foundation drainage system, and utility/municipal sewer system.
- E. Make connections through walls through sleeved openings, where provided.

3.3 INSTALLATION - CATCH BASINS, TRENCH DRAINS AND CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.
- C. Level top surface of base pad; sleeve concrete shaft sections to receive storm sewer pipe sections.
- D. Establish elevations and pipe inverts for inlets and outlets as indicated.
- E. Mount lid and frame level in grout, secured to top cone section to elevation indicated.
- F. Prefabricated trench drains:
 - 1. Excavate; prepare substrate and supports according to the manufacturer's printed installation instructions.
 - 2. Install prefabricated trench drain system according to the manufacturer's printed installation instructions.
 - 3. Expansion, Construction, and Control Joints: Do not locate trench drain system on an expansion, construction or control joint in concrete or pavement. Where concrete or pavement joints running transverse to direction of flow cross the trench drain system, locate concrete or pavement joints and trench drain system joints so that both coincide.
 - 4. Concrete Trench Support: 2,500 pounds per square inch compressive strength, minimum.
 - a. Provide support on all sides of trench in minimum thickness recommended by trench drain system manufacturer.
 - b. Screed and finish top edge of concrete flush with top surface of trench drain system.
 - c. Do not use secondary edge finishing tools.

3.4 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

3.5 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 33 41 11



APPENDIX



**APPENDIX 01
DIVISION 01
GENERAL REQUIREMENTS**

**APPENDIX - DIVISION 01
MISCELLANEOUS OWNER PROJECT REQUIREMENTS**

PART 1 - INTRODUCTION

1.1 GENERAL

- A. This Appendix Section addresses Owner Project Requirements that may be addressed on a Project-Specific Basis and whose implementation occurs across multiple Specification Sections or is dependent upon refinement of the Design and Construction Standards for the Project for appropriate design and implementation.

PART 2 - ROOF FALL PROTECTION

2.1 GENERAL

- B. The following guidelines are intended to provide a basis of Owner preferences and expectations for the design of new and existing buildings and associated roof fall protection systems. Please note the information below is intended to be in accordance with OSHA, DSA and project requirements.
- C. Designer shall hold a "Roof Fall Protection Expectations" meeting with Facilities to review project specific design early in design development. The purpose of the meeting will be to review project scope of work and impact to building roof, identify roof level building components, clarify type of fall protection assumed (leading edge, fall arrest system, parapet, guardrail, etc.)

2.2 NEW BUILDINGS

- A. Provide safe access for maintenance personnel to perform inspection, cleaning and maintenance for roof level building components such as downspouts, roof drains, clearstory windows, mechanical equipment, exhaust fans, electrical equipment, solar panels, etc.
- B. For new buildings, OSHA compliant parapets, guardrail systems, and fall arrest systems are preferred in lieu of OSHA compliant leading-edge designs when roof level building components (including downspouts) are located at the perimeter of the building.
- C. Interior ladder access to the roof is preferred over exterior for safety and aesthetic concerns.
- D. Fixed ladderguard systems are preferred over ballasted systems.
- E. Discrete colors preferred for ladders and guardrail systems.
- F. Designer shall hold a "Roof Fall Protection Expectations" meeting with Facilities to review project specific design early in design development.

2.3 EXISTING BUILDINGS

- A. If parapets exist, ensure parapet height is OSHA compliant following all new work (including built up roofing). Owner expects field verification early in design development.
- B. If new work requires parapet heights to increase, Owner expects structural coordination completed early in design development.
- C. Designer shall hold a "Roof Fall Protection Expectations" meeting with Facilities to review project specific design early in design development.

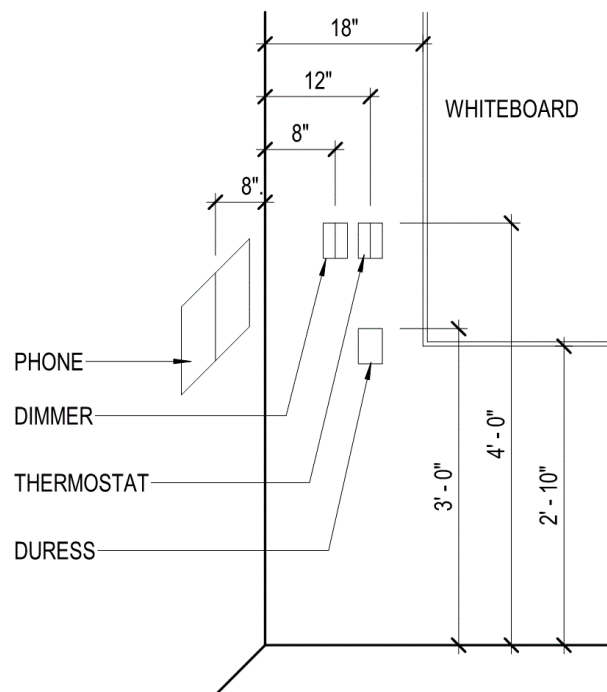
PART 3 - ACOUSTIC PERFORMANCE

3.1 GENERAL

- A. Projects shall utilize existing documents and standards adopted by MiraCosta College as a baseline minimum for acoustical performance and isolation requirements for each space.
- B. Designer shall identify acoustic performance as a program element and meet with stakeholder groups to establish and provide for the specific requirements for the acoustic performance of each space.
- C. Acoustic performance is measured by standards including (but not limited to) IIC, STC, NRC, and NC.

END OF APPENDIX – DIVISION 01

Teacher Controls Clusters – See attached detail for what the cluster includes and example photos. To be located near the teaching wall, close to the instructor’s smart podium / smart desk. Coordinate location of T-stat with the mechanical engineer and location of light switches (2 per Classroom) with the electrical engineer.







APPENDIX 10 DIVISION 10 SPECIALTIES



 **DLR**GROUP

Campus-wide Signage Standards

Mira Costa College

Preliminary Signage Standards Manual

07 / 18 / 2023

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- 1.02 Part 1 - General
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- 3.01 Signage Hierarchy: Series A Signs
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- 4.07-4.08 Sign Type A7: Secondary Freestanding Building Identification
- 4.09 Sign Type A8: Primary Campus Monument
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- 4.11-4.12 Sign Type B1: Primary Vehicular Directional
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- 4.17-4.18 Sign Type B4: Vehicular Directional w/ LED Display
- 4.19-4.20 Sign Type B5: Primary Pedestrian Directional
- 4.21-4.22 Sign Type B6: Secondary Pedestrian Directional
- 4.23-4.24 Sign Type B7: Tertiary Pedestrian Directional
- 4.25-4.26 Sign Type B8: Pedestrian Directional w/ Campus Map
- 4.27 Sign Type C1: Campus Directory Map
- 4.28 Sign Type C2: Freestanding Digital Display
- 4.29 Sign Type C3: Theatre Building Digital Marquee
- 4.30 Sign Type C4: Information Bulletin Kiosk
- 4.31 Sign Type C5: Plant Information Plaque
- 4.32-4.33 Sign Type P1: Primary Parking Lot Identification
- 4.34-4.35 Sign Type P2: Secondary Parking Lot Identification
- 4.36-4.37 Sign Type P3: Parking User Group Identification
- 4.38 Sign Type P4: Parking Lot Identification (Light Pole Mounted)
- 4.39 Sign Type E1: Department Directory
- 4.40 Sign Type E2: Building Directory (Medium)
- 4.41 Sign Type E2.1: Building Directory (Large)
- 4.42 Sign Type E2.2: Building Directory (Small)
- 4.43 Sign Type F3: Blade Directional
- 4.44 Sign Type F4: Corridor Directional (Large)
- 4.45 Sign Type F5: Corridor Directional (Small)
- 4.46 Sign Type F6: Accessible Directional (Wall Mount)
- 4.47 Sign Type F7: Accessible Directional (Post Mount)
- 4.48 Sign Type G1: ADA Room Number Identification (Interior)
- 4.49 Sign Type G1.1: ADA Room Number Identification (Exterior)
- 4.50 Sign Type G2: ADA Permanent Room Identification (Interior)
- 4.51 Sign Type G2.1: ADA Permanent Room Identification (Exterior)

SECTION 04
DESIGN DRAWINGS

- 4.52 Sign Type G2.2: ADA Permanent Room Identification Large (Interior)
- 4.53 Sign Type G2.3 ADA Permanent Room Identification Large (Exterior)
- 4.54 Sign Type G3: ADA Room Identification
- 4.55 Sign Type G3.1: ADA Room Identification Large
- 4.56 Sign Type G4: ADA Room Identification w/ Insert
- 4.57 Sign Type G5: Identification Blade
- 4.58 Sign Type G6: Department Identification Large (Glass)
- 4.59 Sign Type G6.1: Department Identification Small (Glass)
- 4.60 Sign Type G7: Department Identification Large (wall)
- 4.61 Sign Type G7.1: Department Identification Small (wall)
- 4.62 Sign Type H1: Restroom Identification (Interior)
- 4.63 Sign Type H1.1: Restroom Identification (Exterior)
- 4.64 Sign Type H2: Stair Identification (Interior)
- 4.65 Sign Type H2.1: Stair Identification (Exterior)
- 4.66 Sign Type H3: Interior Stairwell Identification
- 4.67 Sign Type H4: Stair Landing Identification
- 4.68 Sign Type H5: Elevator Egress Map (interior)
- 4.69 Sign Type H5.1: Elevator Egress Map (exterior)
- 4.70 Sign Type H6: ADA Exit Identification
- 4.71 Sign Types H7, H8, & H9: Restroom Identification (Door Mount)
- 4.72 Sign Type H10: Maximum Occupancy
- 4.73 Sign Type H11: Assistive Listening System Notice
- 4.74 Sign Type H12: Area of Rescue Assistance/Refuge
- 4.75 Sign Types J1 & J2: No Smoking Notification
- 4.75 Sign Types J3 & J4: No Food or Drink Notice

SECTION
01

General
Specifications

NOTES

Bidders Qualifications

Interested parties **must provide** the following information for evaluation. Submittal must be limited to a single PDF file. Bidders must demonstrate that their company has the experience to build and install signage, environmental graphics and displays similar to the project being bid. Respondent proposals will be used for scoring during the evaluation and selection process.

Failure to provide the requested qualifications will be grounds for disqualification if determined by the selection committee.

01 - COMPANY PROFILE

- Brief history of the company.
- List of market sectors.
- List of notable clients.
- Describe production facilities and special equipment available.
- List of services that can be provided in-house.
- List services that would be subbed out to a 3rd party vendor.
- Describe respondents bond capability.
- Describe any open litigation that the respondent may have.

02 - TEAM

- List of key members of the project team; role, years of experience, years with current company.
- Resumes for key team members; specifically for the Project Manager Field Supervisor and Production Manager.
- Demonstrate that the company/staff is actively involved with SEGSD (Society of Experiential Graphic Design).

03 - EXPERIENCE

- List of relevant projects; name, location, client.
- Minimum of 5 project examples that are comparable to the job being bid; type, scale, scope, materials, date completed and budget. Images must be included.

04 - REFERENCES

- Minimum of 3 references from clients, architects or engineers; project name, scope of work, client name, contact person, phone number and email address.

05 - CAPACITY

- Demonstrate that the fabricator has the capacity and capability to undertake this project. Provide a list of current active projects and projects.

06 - PROJECT FEE

- Outline the proposed fee for the project.

07 - PROJECT SCHEDULE

- Outline the proposed schedule for the project. Indicate key milestone dates and critical meetings.

08 - APPENDIX (OPTIONAL)

- Additional information that may highlight ability to complete the project in a successful manner.

Fabrication and Installation

Fabricator is responsible for the complete fabrication and installation of sign types described in this document, in conjunction with quantities and other details indicated in this or other documentation. Fabricator is responsible for all materials, equipment, labor, shipping, cranes, hoisting equipment, scaffolding, and clean-up of site. Vendor is responsible for completion of all sub-contracted services.

All on-site work will be coordinated through Client (Owner), General Contractor, or Architect and must be approved before delivery of signage, materials or installation equipment.

Fabricator to review structural, architectural, and M.E.P. drawings or site conditions to verify sizes and locations of signage related elements that are to be provided by the General Contractor. Any discrepancies and/or conflicts shall be reported to the Owner's representative in writing before proceeding with fabrication or ordering materials.

Fabricator shall submit fully-detailed working (shop) drawings of all signs and graphics contained in this package. Drawings shall be reviewed and have signed approval prior to fabrication or ordering of materials.

All signs are to be fabricated from materials specified unless otherwise approved in writing by Client and Experiential Graphic Designer. No exceptions.

Fabricator is responsible for determining proper mounting, fastening and anchoring methods for all signs unless otherwise specified. Sign Fabricator to coordinate need and location of blocking with General Contractor or other affected trades. Blocking to be coordinated between sign fabricator and Design Build Contractor and will be provided by cold form metal framing subcontractor.

Power will be available within a j-box within 5 feet of applicable sign locations. Fabricator responsible for providing electrical connection to all illuminated and powered signs per local codes. Exposed hardware (i.e. conduit, j-boxes, etc.) will not be accepted.

Drawings contained in this package are for aesthetic and functional design intent, only. No instructions for structural appropriateness have been made. It is the responsibility of the fabricator to provide engineered, stamped shop drawings for those elements noted and to ensure that all elements are fabricated for a stable and durable installation while adhering to the aesthetic details indicated.

Fabricator is responsible for determining proper mounting methods for all signs unless otherwise specified. Determination to account for surface material sign is being mounted to.

Fabricator to coordinate installation of site signage and associated footings with General Contractor's installation of surrounding hard-cape.

All fasteners are to be concealed unless noted otherwise.

All text shown in this document is for reference only, unless noted otherwise. Reference Message Schedule for exact text on each sign.

For sign types requiring concrete footings, fabricator is responsible for reviewing all drawings and pertinent information for each sign location in order to understand the conditions in which they will be placed. This information is to be utilized as appropriate for preparing engineered shop drawings. Sign fabricator to engineer all sign fastenings and supports.

Installation of specific signs may vary within each group to accommodate construction schedules of other project items. All installation tasks will be coordinated with Owner before delivery, staging or installation labor begins. Fabricator may be provided a small staging area for sign installation. No long-term storage of sign components and/or installation equipment will be allowed on the project site.

Permits and Regulations

Fabricator will procure all permits, licenses and governmental approval necessary for the execution of the project. Fabricator will comply with all laws, ordinances, rules, order and regulations relating to the performance of the work, the protection of the adjacent property, and the maintenance of passageways, guard fences or other protective facilities. Fabricator will follow without delay all instructions and orders given by Owner with consultation from DLR Group, in the performance of the work.

Guarantee

All work will be guaranteed against defects in materials and workmanship for a minimum of 1 year from date of substantial completion.

The guarantee will include structural performance, materials, adhesives and fasteners of all items, supplied and installed, and that finishes will not peel, fade, craze, deteriorate or release during the guarantee period.

Other guarantees or warranties provided by equipment, hardware, material or subcontracted services will be provided to the Owner.

During either construction or product (LED's, drivers) warranty period, Owner notifies installing sign vendor who will investigate, assess and remediate issue on behalf of Owner, to Owner's satisfaction.

Taxes

Fabricator is responsible for any required employment related taxes. Owner will be charged for all required sales taxes and they have been included by the respective contractors in their bids.

PART II – PRODUCTS

2.1 - MATERIALS, GENERAL

Use materials of size and thickness indicated or, if not indicated as required to produce strength and durability in finished product for use intended. Work to dimensions shown or accepted on shop drawings, using proven details of fabrication and supports. Use type of materials shown or specified for various components of work.

All materials shall be new stock, free from defects impairing strength, durability, and appearance. No fabrication or installation materials or procedures shall be used that will in any way change the quality or in any manner have an adverse effect on existing materials and surfaces. All materials will be of sufficient strength as to prevent warping, oil-canning or other undesirable deflection.

Graphic Content and Style: Provide sign copy that complies with requirements indicated in the Graphics and Message Schedule, Drawings, and on artwork supplied on electronic media by Owner for size, style, spacing, content, mounting height and location, material, finishes, and colors of signage.

Requests for substitutions will only be considered in accordance with the following conditions: Refer to CSI – Section 01 60 00 for requirements. All requests must be in writing and submitted to Architect prior to bids, substitution requests must include complete product documentation, MSDS, product specification, samples of proposed product and include costs of substitution for related work. Samples will not be returned.

2.2 - METALS

For the fabrication of exposed metal work, use only materials which are smooth and free of surface blemishes including pitting, roughness, seam marks, roller marks, and trade names. Do not use materials which have stains or discolorations. Provide stretcher leveled standard of flatness. Aluminum Sheet and Plate: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of alloy 5005-H15. Thickness: Provide aluminum sheets and plates in sizes specified or indicated on the Drawings.

Aluminum extrusions: ASTM B 221 (ASTM B 21M), alloy and temper recommended by aluminum producer and finish for type of use and finish indicated, and with at least the strength and durability properties of alloy 6063-T5.

2.3 - TYPOGRAPHIC REQUIREMENTS

General: Type style shall be as indicated on the Drawings. Typeface and numerals shall be computer digitized by one manufacturer and used for each applicable sign types. Characters indicated on the Drawings are intended as guidelines for layouts and font size only, and are based on scale calculations of the message lengths within given and estimated sign areas. Drawings and schedules indicate the copy required on individual signs. Should conflicts arise in the final message layout, notify Owner before proceeding. Spelling and punctuation shall be correct. Should an error in spelling or punctuation be found, or the spelling appears questionable, notify Owner before proceeding. Align letterforms to maintain a baseline parallel to the sign format, unless otherwise indicated. Maintain uniform margins in sign layouts.

Suite Identification Signs: Owner will determine names of each individual suite onto the Message Schedule.

Silkscreens shall be executed from photoscreens or negatives. Pattern cut screens maybe used where non-repeat copy is required; however, copy mask shall be equivalent to photoscreen quality. Do not use images indicated on the Drawings as camera-ready art. All Ink must be Nazdar or equal (VE substitutes may be acceptable upon request/approval).

2.4 – PLASTIC

Plastics, acrylics and polycarbonates will be free of imperfections from forming or fabrication. All surfaces will be free from scratches and will be cleaned and polished per manufacturer's instructions at completion of installation. Edges will be laser cut or routed and free of saw marks and chips, and be eased, unless otherwise noted.

Push-Thru Letter faces:

- 1/4" thick Acrylite Sign Grade WRT30 White acrylic (Evonik Ind.) (Available in 75" x 125" max sheet size)

Vinyl Stencil sign faces and Illuminated Letter faces:

- .177" thick WT030 White acrylic (Evonik Ind.) (Available in 75" x 125" max sheet size)

2.5 - GRAPHIC FILM

General: Provide vinyl graphic film suitable for interior and exterior applications of types indicated below.

Vinyl Thickness: 2 mil (0.05 mm), minimum.

Adhesive: Clear, pressure sensitive, permanent adhesive. Acceptable Vinyl Films: No Exceptions or substitutions:

- 3M Custom Envision Translucent Film
- 3M Custom Scotchcal Translucent Film
- 3M Scotchcal Translucent

30 day outgas on painted surfaces required, paint used on surface by others must first be approved by 3M representative.

Heat Applied Vinyl:

- Wall surface must be washed with water (if concrete or brick)
- Wall surface must be primed if concrete is new. Zinsser All-Prime Clear (water base problem surface sealer) to be used over the top of all painted walls for optimal vinyl adhesion
- 3M 8520 Matte Overlam (never gloss finish)
- Paint/Primer MUST outgas for a minimum of 30 days
- Preferred temperature of surface is 50 degrees or higher
- A pull test must be performed and passed after all of these conditions have been met (must use a 3M approved kit)
- Installation must be by 3M approved installer

2.6 - HARDWARE, FASTENERS, AND ADHESIVES

Furnish and install all mounting and anchoring hardware and devices as required to completely install all work.

Mounting hardware must be approved by Owner. Unless otherwise indicated, use concealed fasteners fabricated from metals that are non-corrosive to either the sign material or the mounting surface. If concealed fasteners are not practical or possible, provide vandal-resistant fasteners. All such visible hardware will match both color and finish to which it is attached, or as specified in Design Specifications.

Awarded sign company to provide engineered seismic fasteners and hardware when required.

Fabricate brackets and fittings for bracket-mounted signs from materials compatible with panel sign construction and mounting conditions indicated. Factory-paint brackets in color matching background color of panel sign, unless otherwise indicated on the sign type detail.

Steel Tubing: Cold-formed steel tubing complying with ASTM A500, Grade B. Structural Steel Shapes, Plates, and bars: Cold formed steel fabrications complying with ASTM A36. Aluminum Structural Tubing: Alloy 6061 for all aluminum structural tubing must be used.

Anchors and Inserts: Use non-ferrous metal or hot-dipped galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work. For attachment to metal panels, use #12 stainless steel, Type 410, self-tapping screws with integral neoprene washers.

Adhesives: Provide products equal to "Depend 330" as manufactured by Loctite Acrylic Adhesives. 216/881-2828.

Signage manufacturer shall verify with painting manufacturer capability of the adhesive to the paint.

Very High Bond (VHB) Foam Double Face Tape: Provide vinyl double-sided foam tape of thickness required, and manufactured by 3M, or approved equal.

Silicone Adhesive: Provide liquid silicone adhesive (sealant) with a methanol or acetic cure as recommended by the sign fabricator.

Rubber Spacers: Provide Manufacturer's standard spacers when necessary.

2.7 - FABRICATION, GENERAL

Fabricate signs to comply with requirements indicated on designs, shapes, sizes, and details of construction.

Form exposed faces and sides of signs to produce surfaces free from warp and distortion and free of "oil canning."

Include internal bracing for stability and attachment of mounting accessories as required. Cut metal edges on a continuous line and sand smooth. Seams will be straight and symmetrical. Form exposed connections with hairline and level with sharp angles, surfaces, and edges. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or cracking.

Welding, when necessary, will be of the approximate type to minimize permanent distortions of flat surfaces. Remove welding flux, oxides and discolorations by pickling or grinding, so that these areas match the finish of the adjacent areas. Repair damage caused by the fabrication by grinding, polishing or buffing. Weld corners and seams continuously complying with AWS recommendations. At connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces. Cut, reinforce, drill, and tap miscellaneous metal work as indicated to receive finish hardware and similar items. Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions within a tolerance of plus or minus one percent measured diagonally from corner to corner.

Fabricate brackets and fittings for signs to suit sign panel construction and mounting conditions indicate. Connections, angles, shapes and details shown are suggestive and are to be sized, reinforced and detailed as required. Details not shown are to be equal in quality to those detailed. Factory paint brackets in color matching background color of sign panel.

Provide concealed access to internally illuminated signs for Re-lamping and service. Service access will be waterproof and secured against vandalism. Conceal union, fabricator, or other labels.

For sign panel units in exterior applications provide standard Weatherproofing construction, including weather-stripping, weeping, and venting provisions for condensation control. Metal signs facing and cladding will be aluminum unless otherwise indicated or specified.

Where galvanized steel and aluminum meet, the materials will be materially isolated from one another to prevent electrolytic action. Aluminum joints and connections will be heliarc welded and flush, true, ground, and polished smooth and without defects.

Character forms will be cut true to typeface with no burns or imperfections of any kind.

Provide completely hidden, internal structures for support and anchorage, unless indicated otherwise on the drawings. Primary support structure will be hot dipped galvanized steel or aluminum.

Electrical: Vendor is responsible for all LED Modules and other electrical components and associated wiring of individual signs. Vendor will provide minimum amount of points necessary for electrical connection. Electrical wiring and conduit from building to sign location is the responsibility of Owner. Final electrical hook-up is the responsibility of Owner. Illuminated signs will include photocells, timers, rheostats, transformers and other devices necessary for proper operation. Vendor is responsible for providing all requested electrical information regarding signs to Owner.

Changes and Alterations: All modifications or changes from Design Specifications will be called to the attention of Owner and explained. Changes from the Design Specifications Document, not specifically prior approved, will be corrected by Vendor at no additional expense to Owner. Any modifications requested by Owner that result in an increase in fabrication or installation cost is the responsibility of Owner, if approved prior to execution of work. All modifications requested that result in a decrease in cost will be credited to Owner. All changes that result in a change in the cost of fabrication and/or installation of the project will be submitted to Owner for approval prior to execution of work.

PART II – PRODUCTS CONTINUED

2.8 - PANEL SIGNS

Exterior Plaque sign: Provide products fabricated from 0.125-inch aluminum plate with 0.030 inch thick double face tape mounting and silicone adhesive. Sign copy shall be raised 1/32 inch from plaque first surface by manufacturer's standard thermoform monolith sign process. Provide opaque graphics to comply with regulations.

- Finish: Manufacturer's custom color MAP.
- Graphics: As indicated on the Drawings using 3M vinyl films.

Interior Plaque Signs: All ADA and tactile products must be fabricated using compression molding technology (Tactile Thermoforming or Photopolymer). Signs must be made from specified acrylic, or solid surface materials. Sign copy shall be integral to sign face and raised a minimum of 1/32" from plaque first surface by specified manufacturer's standard thermoform monolith sign process (or equal). Copy color must be integral (or tipped) see drawing for what is specified. Integral copy color will ensure color of character returns will match character surface thereby maximizing durability and longevity. Braille color to match background color. Graphics and braille must comply with building code and ADA regulations.

- Finish: Manufacturer's custom color with matte finish.
- Surface textures: See drawing for surface texture specification Smooth, Slate, Stipple, Ultra, Wood, Leather are available
- Graphics: as indicated on the Drawings.

Notice: Applied appliqué, bead braille or 3M embossed are not acceptable substitutions and will be rejected at submittal or prototype phase. Sign vendor to supply samples to designer for approval prior to fabrication and installation.

2.9 - FABRICATED LETTERS AND NUMBERS

Channel Characters: Fabricate letters and numbers to the required sizes and styles, using metals and thickness indicated in the drawings. Form exposed faces and sides of characters to produce surfaces free from warp and distortion. Include internal bracing for stability if needed and attachment of mounting accessories as required. Fabricate by the heliarc welding process.

- Materials, finished and colors as specified in the drawings
- Height and width dimensions as determined by specific location requirements and city codes. Reverse Channel Characters: Fabricate letters and numbers to be the required sizes and styles, using metals and thickness indicated below. Form exposed faces and sides of characters to produce surfaces free from warp and distortion. Include internal bracing for stability and attachment of mounting accessories as required. Fabricate by the heliarc welding process.
- Materials, finished and colors as specified in the drawings
- Height and width dimensions as determined by specific location requirements and city codes.

2.10 - ILLUMINATION

Exterior signs must illuminate the entire face evenly. There must be no obvious dark areas or hot spots. LEDs or lamps specified to be mounted at a distance less than the specified depth or return of a fabricated cabinet, Vendor will include an intermediate level to support light source and maintain desired sign depth.

All Illuminated Signage: Provide LED illuminated sign systems for exterior applications as indicated on the drawings. Include LED's, transformers, and other components necessary for complete systems. Entire face of signs must be illuminated evenly. There must be no obvious dark areas or hot spots. Make provisions for servicing and concealing connections to building electrical system. Coordinate electrical characters with those of power supply provided. Loading shall be verified by following the testing procedures recommended by the LED-systems manufacturer.

- Sloan*
- Bitro *

Natural spacing for these modules is 2.5 modules per foot Cabinet and Pylon Signs: Natural module to module spacing (2.5 per ft.). Row to row spacing of 3.5" to 4" on center. Channel Letters: Module to module spacing of 3 mods per ft. Row to row spacing of 4" on center. Refer to the Sloan LED layout dept. and these guidelines will be followed for all Owner layouts. Power Supply Options:

- Advance 12V, 60W, 120Vac (200-S3I-PS1260)*
- Advance 12V, 60W, 120-277Vac (200-S3I-PS1260V)*
- Sloan MODW 60W, 100-240V (#701507-MODW)*
- Sloan MOD277 60W, 277-347V (#701507-MOD277)*

**Requests for substitutions will only be considered in accordance with the following conditions: Refer to CSI – Section 01 60 00 for requirements. All requests must be in writing and submitted to Architect prior to bids, substitution requests must include complete product documentation, MSDS, product specification, samples of proposed product and include costs of substitution for related work. Samples will not be returned. All electrical fixtures must be UL approved.*

2.11 – FINISHES, GENERAL

All edges of materials are to be finished to match sign face or as specified by the Design Specifications. No unfinished or rough edges are permitted. All surface laminates, paint or other surface finishes will be applied to exposed edges of material.

All paint, ink, sheet vinyl, digital or photographic prints are to be applied evenly, without pinhole, scratches, orange peeling, uneven edges, application marks, rough edges, etc. All paint finished are to be Matthews Acrylic Polyurethane (MAP), unless otherwise specified. Prime coats or other surface pretreatments, where recommended by the manufacturers will be included in the work as part of the finishes surface work.

Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations damage by applying strippable, temporary protective covering before shipping.

Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

Preparation: Substrates shall be smooth, clean and free of dust, grease, fingerprints, or other foreign matter. If necessary to obtain true color application, surface shall be "primed" with white before final color application is applied.

Artwork shall be accurately reproduced with all edges straight and true and all finishes smooth with no visible imperfections. Surface preparation: Follow paint manufacturer's instructions for preparing surfaces before applying primers or graphics.

Corrosion Protection: Coat concealed surfaces, which will be in contact with concrete, stone, masonry, wood, or dissimilar metals, in exterior work and work to be built into exterior and below grade walls and decks, with a heavy coat of bituminous paint. Do not extend coating onto exposed surfaces.

Colors and Surface Textures: For exposed sign material that requires selection of materials with integral or applied colors, surface textures or other characteristics related appearance, provide custom color matches as selected by the Architect.

- Aluminum: MAP paint as specified in this section.

2.12 - ALUMINUM FINISHES

Aluminum: Finish designations prefixed by AA conform to the system established by the Aluminum Association for AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte, Anodic Coating: Architectural Class 1, clear coating 0.018 mm or thicker) complying with AAMA 611.

2.13 - PAINT MATERIALS

All paint materials are to be applied per paint manufacturer's recommendations including surface preparation, priming, number of coats required, sanding in-between coats, and top coat finish.

Primer: High build, two-part polyamide epoxy.

Opaque Finish Coat: Satin finish, two-part satin finish acrylic polyurethane paint. Provide products equal to Matthews Paint Company's "low VOC Satin MAP – Acrylic Polyurethane," custom colors with gloss between 11 and 19 units @ 60 degrees.

Silkscreen: Use Nazdar fast drying opaque enamel silkscreen ink.

Colors and Sheen: High gloss, satin or matte color not limited to manufacturer's standard colors.

PART III – EXECUTION

3.1 - PREPARATION

General: Examine area, surfaces and conditions under which the work is to be installed. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Starting work implies acceptable surfaces and conditions.

3.2 - INSTALLATION

Installation will be done by Vendor or under the supervision by authorized agents of Vendor. Any questions or discrepancies will be resolved by Owner. A pre-installation meeting will be scheduled by Vendor between Owner and Vendor to review and finalize all details involving the installation of this project. Vendor will coordinate delivery and installation schedule with Owner.

Vendor will clean, remove protective coatings, or polish as required by manufacturer's or Owner's instructions. Remove all crating, debris and previous signs from project site.

General: Locate sign units and accessories where shown on Sign Schedule and/or sign reference plans, attaching signs to substrates in accordance with manufacturer's instructions, unless otherwise indicated. Install signs level, plumb, and at heights indicated, with sign surfaces free from distortion and other defects in appearance.

Surfaces under adhesive applied units shall be smooth, clean, and free of dust, grease, fingerprints, or other foreign matter. All adhesives required shall be used in accordance with recommendations made by manufacturer of the material to be laminated or adhered. No adhesives that will fade, discolor, or delaminate as a result of ultraviolet light or heat shall be used. Adhesives shall not change the color of or deteriorate the materials to which they are to be applied. The adhesives shall be of non-staining, non-yellowing quality. All visible joints shall be free from air bubbles and other defects. Mill joints to a tight, hairline fit. Form joints exposed to the weather to exclude water penetration.

Wall-mounted Panel Signs: Attach panel signs to wall surfaces using methods indicated below.

- Flush-Mounting: Mount panel signs with backs in contact with wall surface.
- Vinyl-Tape Mounting: Use double-sided foam tape to mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
- Hook-and-Loop Tapes: Use hook-and-loop tapes to mount signs to smooth, nonporous surfaces.
- Magnetic Tape: Use magnetic tape to mount signs to smooth, nonporous surfaces.
- Silicone-Adhesive Mounting: Use liquid-silicone adhesive recommended in writing by sign manufacturer to attach signs to irregular, porous, or vinyl-covered surfaces. Use double-sided vinyl tape where recommended in writing by sign manufacturer to hold sign in place until adhesive has fully cured.
- Shim Plate Mounting: Provide 1/8 inch (3 mm) Thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other mounting methods are not practicable. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach panel signs to plate using method specified above.
- Mechanical Fasteners: Use non-removable mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended in writing by sign manufacturer.
- Where panel signs are scheduled or indicated to be mounted on glass, provide matching plate on opposite side of glass to conceal mounting materials.

Glass Mounted Signs: Pressure sensitive adhesive film as recommended by manufacturer in standard 3M vinyl colors. See Message schedule for quantity of signs requiring Glass Mounted Backers (GMB).

- Dimensional Characters: Mount characters using standard fastening methods detailed in the drawings for character form, type of mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish character spacing and to locate holes for fasteners.
- Pin Mounting: a minimum of three threaded studs (1/8 inch diameter by 1/2 inch long minimum) welded to back or bottom of character with no distortions or discolorations to sign face. Appropriately increase size of studs according to weight of characters.
- Flush Mounting: Mount characters with backs in contact with wall surface.
- Projected Mounting: Mount characters at projection distance from wall surface indicated. With painted spacers. Bracket-Mounted or Suspended Units: Use custom Fabricated brackets, fittings and hardware as appropriate for mounting signs which project at right angles from supporting elements or suspended from structural members. Attach brackets and fittings with concealed fasteners and anchoring devices, unless otherwise indicated, to comply with the manufacturer's directions.

Illuminated Characters: Run wires into wall construction through conduit. Use insulators as necessary for neon lighting wiring. Exposed-to-view wiring or conduit on wall face is not permitted. Engage a licensed electrician to connect wiring to power source.

Foundations: All footings and foundations are the responsibility of Vendor unless otherwise noted. Foundations are to be engineered to support weight and wind-load of signs and be installed below the local frost line to prevent shifting and heaving. All concrete will be rated sufficiently for the task and include steel reinforcement. Concrete slabs and exposed footings will be finished to match nearby sidewalks, curbs or driveways.

3.3 - FIELD QUALITY CONTROL

Punch List: Within two weeks of scheduled completion of installation, prepare a punch list itemizing the following:

- Improper alignment of letters on sign panel.
- Improper alignment of signs.
- Chipped finishes
- Unpainted exposed fasteners.
- Fabricator's label displayed.
- Improper cleaning of sign surfaces or surrounding wall areas.
- Damage to surrounding surfaces.
- Missing signs.
- Incorrect Messages
- Repair or replace damaged units as required after owners final inspection.

Changes and alterations: All modifications or changes from Design Specifications will be called to the attention of Owner and explained. Changes from the Design Specifications document, not specifically approved, will be corrected by Vendor at no additional expense to Owner. Any modifications requested by Owner that result in an increase in fabrication or installation cost is the responsibility of Owner, if approved prior to execution of the work. All modifications requested that result in a decrease in cost will be credited to Owner. All changes that result in a change in the cost of fabrication and/or installation of the project will be submitted to Owner for approval prior to execution of work.

Delivery, Storage and Handling: Package material in like groups and label accordingly. Protect items during transit, delivery handling, and storage to prevent damage, soiling, and deterioration. Minor damages to the finishes may be repaired provided the final finishes are equal to the original finishes. If not acceptable, remove and replace damaged items with new signs. Coordinate delivery and storage of sign materials with Owner. Schedule delivery to minimize storage requirements. Materials stored at the Project Site without prior approval of Owner, may be relocated at Vendor's expense.

Protection and Repair: Vendor must take steps to protect buildings and surrounding areas as necessary to prevent damage during installation. Any work or property damaged will be restored to original condition and Vendor will be charged with the expense.

Vendor is responsible for general clean-up of site area but is not responsible for extensive landscaping or restoration of architectural elements due to damage or sun bleaching by previous signs.

Final Review: After installation, Owner will review project site and create a punch list of items that do not match approved shop drawings to be repaired, replaced or modified. Vendor is responsible for correcting all items on the punch list without additional cost to the Owner, unless item is beyond the original scope of work. A final message schedule with all as-installed information will be provided by Vendor to Owner. At completion of installation, clean exposed sign surfaces in accordance with the manufacturer's instructions. Signs will be free of glue, fingerprints, dirt, grease, or any other imperfections. Evidence of installation work for damages incurred on other surfaces will be cleaned or repaired prior to completion of work. Protect units from damage until acceptance by Owner. Remove all packing and construction materials from site. Leave premises clean, ready for work under other contracts or ready for use.

Maintenance Data: Information regarding the ongoing maintenance and cleaning requirements will be included in maintenance manuals. Furnish Owner with a list of cleaning materials appropriate for maintenance of signs. Provide written instructions for proper maintenance, electrical access, and character and lighting replacement procedures. Include recommended methods for removal of residual adhesives from wall surfaces after removal of adhered signs. Instruct Owner in writing as to the correct operation and maintenance of all signs and sign components.

3.4 - PATCH AND ADJUST

Patch existing surfaces damaged as a result of work under this section. Patch with same materials as existing. Sign vendor shall paint and harmoniously blend and contour all repairs to match adjoining conditions. Touch-up any marks or nicks in painted finishes of all signs and adjacent structures.

Touch-up shall be the same paint product as used for this Sign finish.

Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals with heavy coat of bituminous paint.

Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.5 - CLEANING AND PROTECTION

At completion of installation, clean exposed sign surfaces in accordance with the manufacturer's instructions. Signs shall be free of glue, fingerprints, dirt, grease or any other imperfections. Evidence of installation work or damages incurred on other surfaces shall be cleaned or repaired prior to completion of work. Protect units from damage until acceptance by Owner.

Remove all packing and construction materials from site. Leave premises clean, ready for work under other contracts or ready for use.

Instruct Owner in writing as to the correct operation and maintenance of all signs and sign components.

Document on construction drawings, provided to Owner, the operation directions of all access panels, and replacement of lamps, ballasts, and transformers as applicable.

3.6 - SCHEDULE OF PROTOTYPES

Prototypes - full size or otherwise specified of required sign types to be provided for owner approval. ALL paint/vinyl/color samples to be submitted to owner and client for review and approval. Progress photos submitted to designer during fabrication on a weekly basis or otherwise requested.

Prototypes of similar construction are required to ensure that all fabrication specifications and materials are followed per the guideline shop drawings and 10-1400 specifications.

Prototypes of similar construction will be due 2-3 weeks from acceptance of preliminary Shop Drawings and may be used for the final scope of work if approved.

3.7 - MONUMENT SIGN

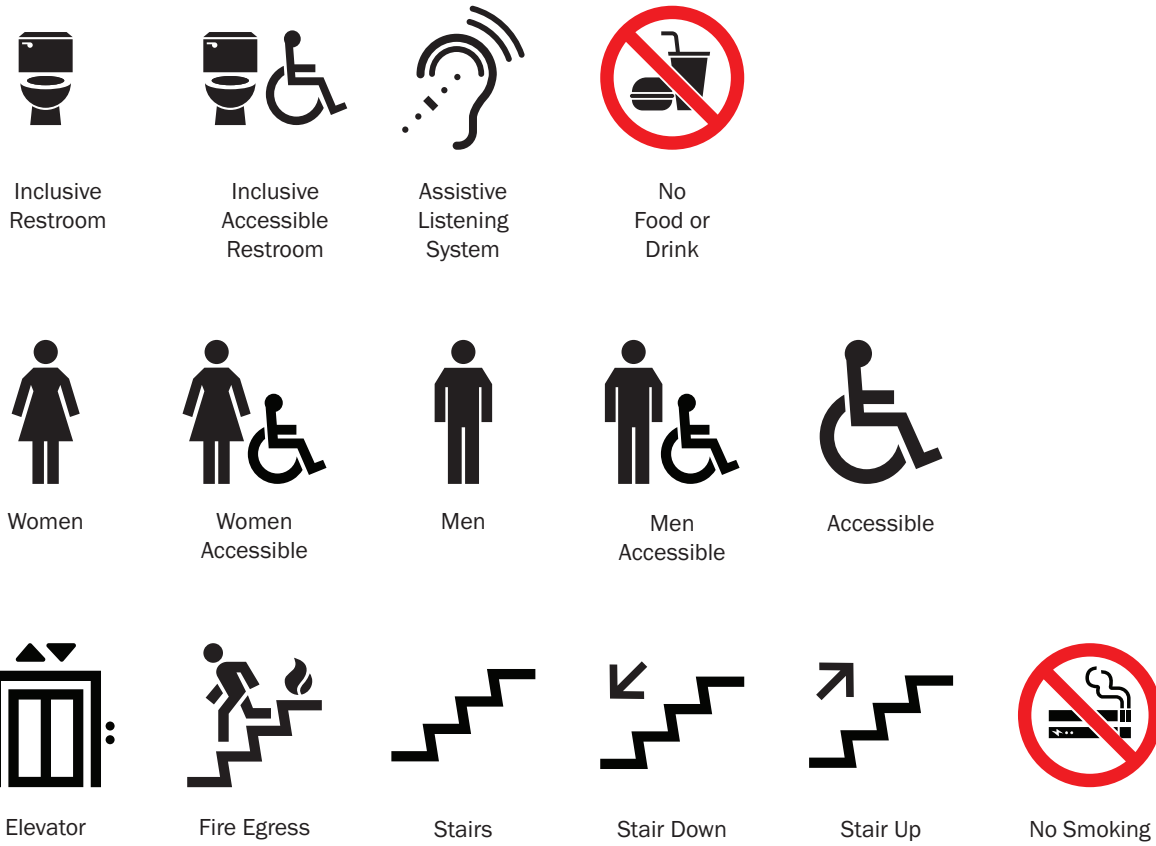
Please refer to the architectural spec for the specifications that covers concrete, brick, metal flashing and composite metal panels. The materials used on the monument sign will be similar to what is being used on the building.

SECTION
02

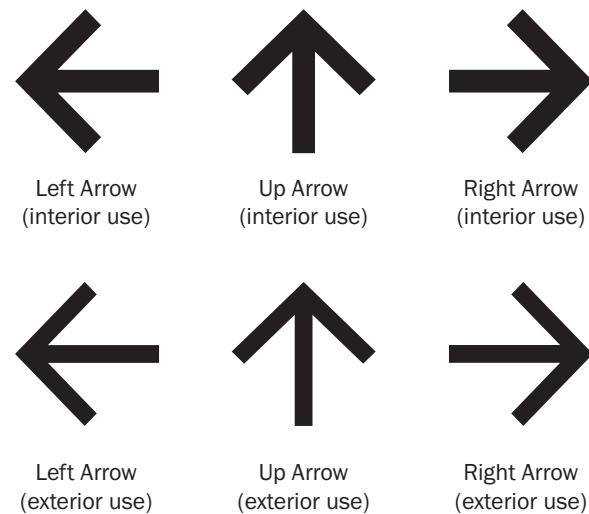
Graphic/Brand
Standards

MiraCosta College District
Standards

SYMBOLS



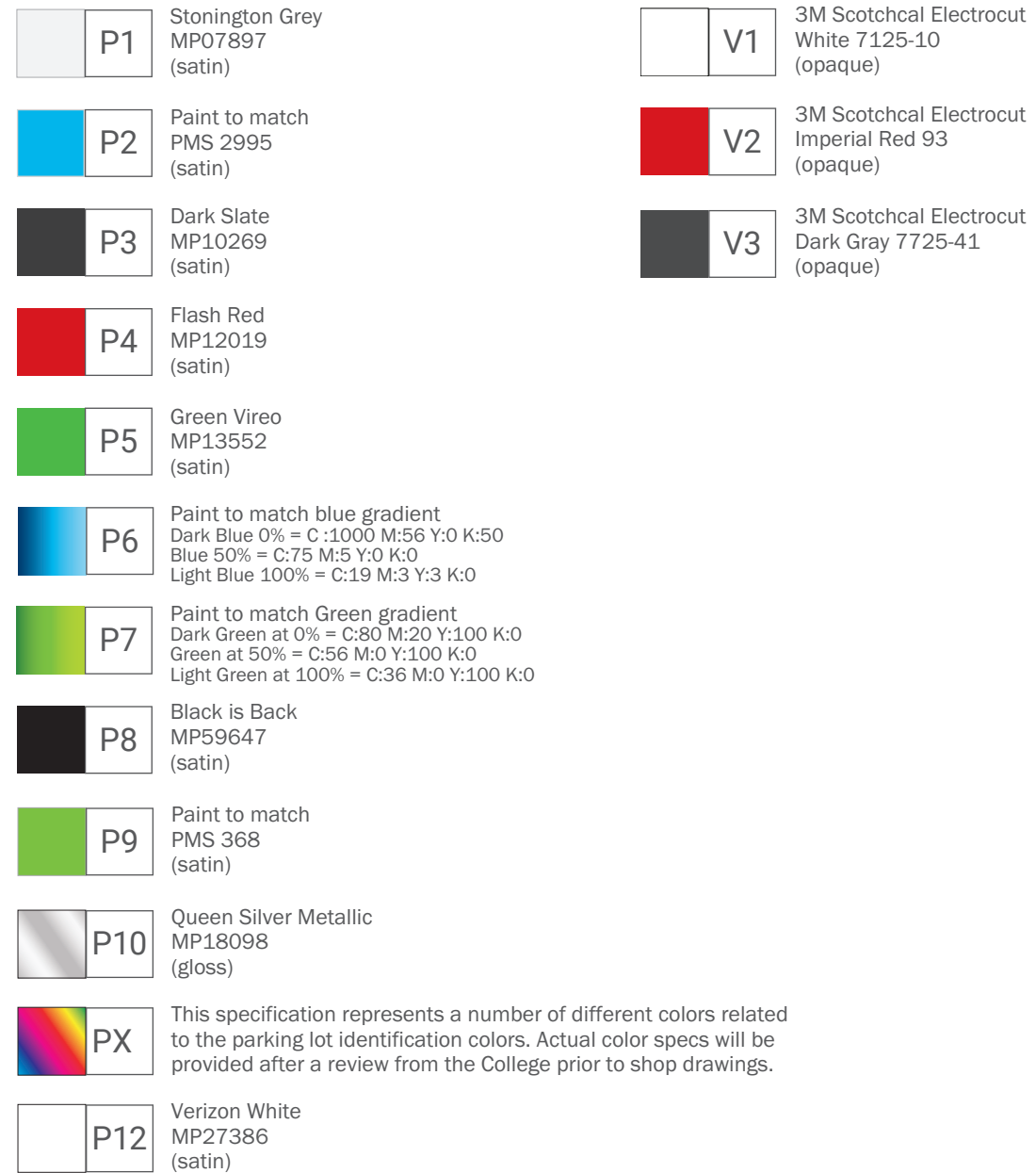
ARROWS



LOGOS



COLORS & MATERIALS



MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS

Oceanside, CA
75-22602-00
July 18, 2023

Preliminary Signage Standards Manual

FONTS

Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk Ll Mm Nn
Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy Zz
0123456789

ITC Avant Garde Gothic Pro - Book

Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk Ll Mm Nn
Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy Zz
0123456789

ITC Avant Garde Gothic Pro - Medium

**Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk Ll Mm Nn
Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy Zz
0123456789**

Sofia Pro Condensed - Semi-Bold

Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk Ll Mm Nn
Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy Zz
0123456789

Sofia Pro Condensed - Regular

Aa Bb Cc Dd Ee Ff Gg Hh Ii Jj Kk Ll Mm Nn
Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy Zz
0123456789

Sofia Pro Condensed - Light

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

Preliminary Signage Standards Manual

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

DRAWING NOTES

Alternate color schemes are available for the interior building signage and may only be used with expressed written approval from MiraCosta College.

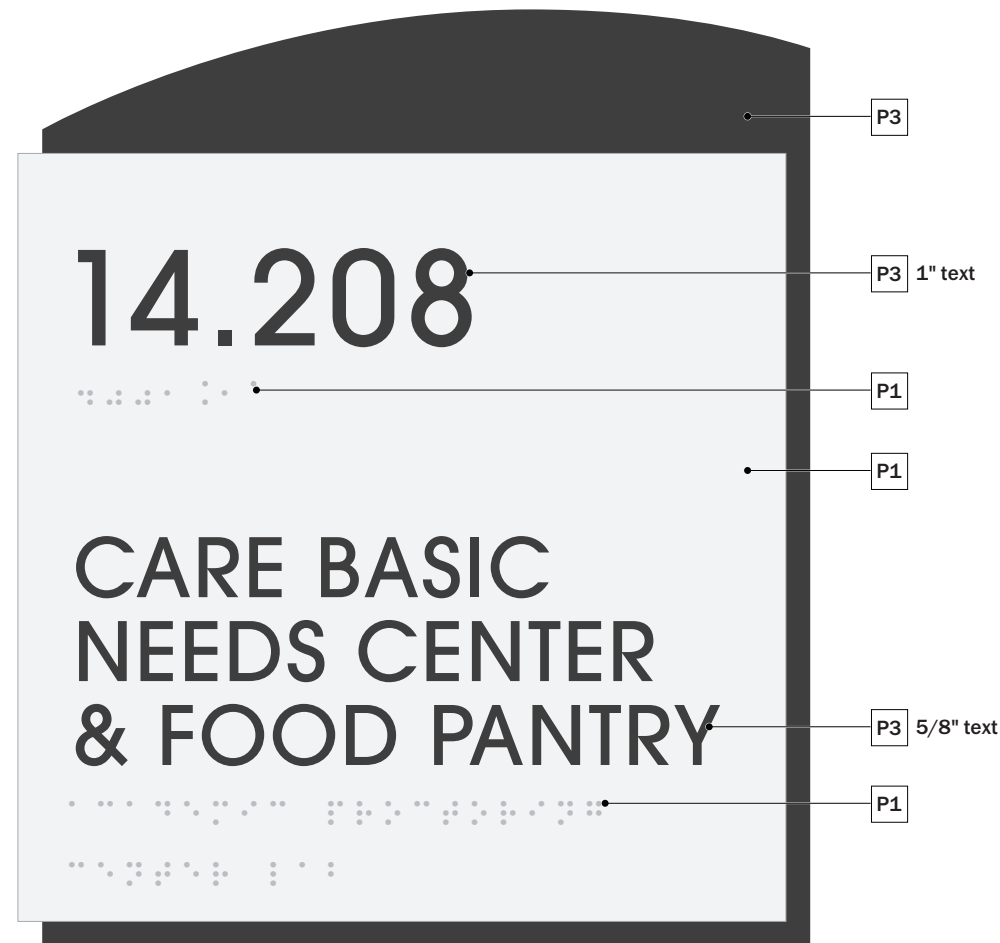
Alternate color schemes shall not deviate from those shown on this page.

Alternate color scheme signage, when approved, should be used throughout the entire project.

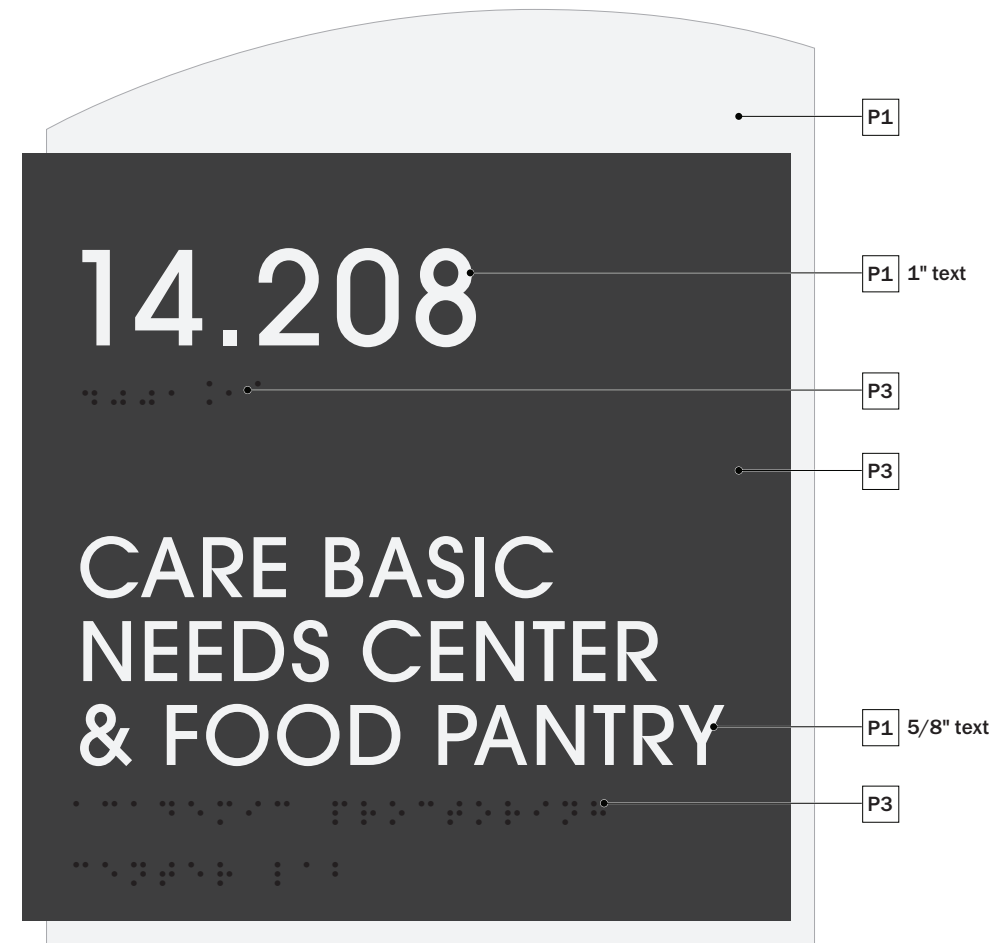
Alternate color schemes should not be mixed with each other nor shall they be mixed with the default color scheme.

The colors shown here are representative of colors to apply to similar sign types. Text to be either P1 or P3 with contrasting sign face panels and a backer panel that contrasts the face panel.

Exterior signage should maintain the default sign scheme.



ALTERNATE COLOR SCHEME A
SCALE: Half Size



ALTERNATE COLOR SCHEME B
SCALE: Half Size

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**ALTERNATE COLOR SCHEME
OPTIONS**

DRAWING NOTES

If two identical sign types or signs of the same width are ever mounted back-to-back on glass, the sign opposite the primary room or primary corridor should have the backer panel reversed to avoid seeing the arches from both signs in opposite directions.

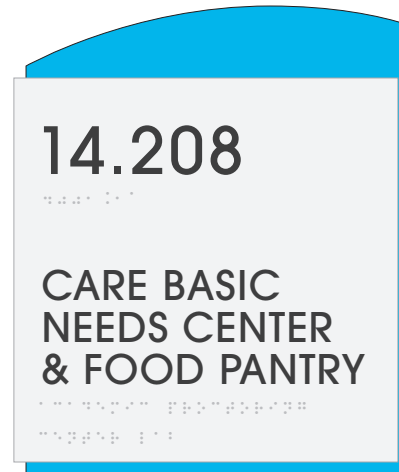
Using a backer panel with an opposite arch will allow the signs to align perfectly when mounted back-to-back on glass.

Notate signs with a reversed backer in the sign location plans to account for signs mounted back-to-back on glass.

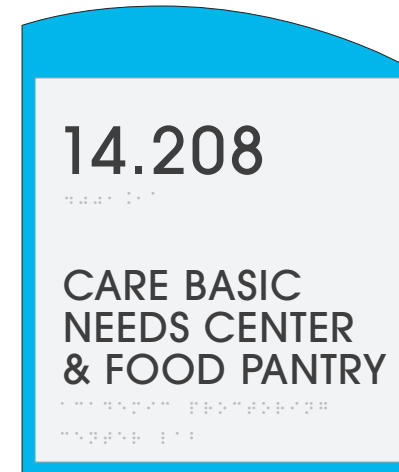
If two signs are mounted back-to-back and are of different widths, use a vinyl backer on the wider sign to conceal the mounting tape and adhesive from view as is typically required on glass mounted signs.



AVOID BACK-TO-BACK MOUNTED SIGNS ON GLASS FROM HAVING COMPETING ARCHES VISIBLE



USE A RIGHT ARCHING BACKER FOR THE SIGN WHICH WOULD FACE THE PRIMARY (LARGER) ROOM OR CORRIDOR.



USE A LEFT ARCHING BACKER FOR THE SIGN OPPOSITE THE PRIMARY ROOM OR CORRIDOR.



All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

SECTION
03

Signage Hierarchy

STUDENT SERVICES

A1 - Primary Building Identification
(Facade Mounted)



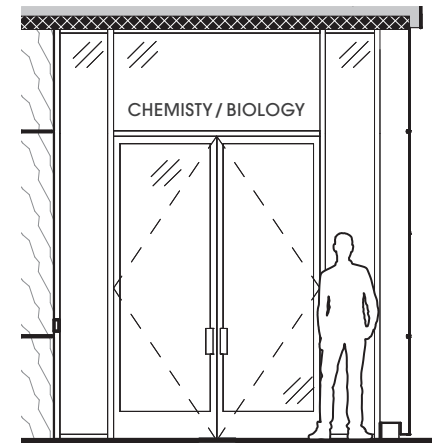
A3 - Building Logo
(Facade Mounted)



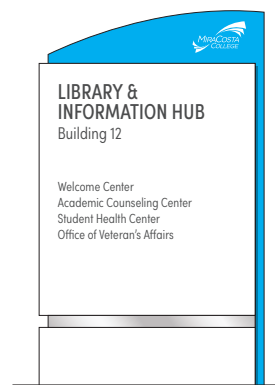
A4 - Building Number Identification
(Facade Mounted)

STUDENT SERVICES

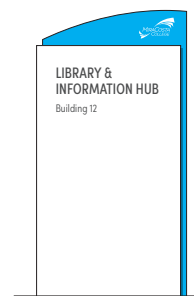
A2 - Secondary Building Identification
(Facade Mounted)



A5 - Tertiary Building Identification
(Glass Application)



A6 - Primary Freestanding Building Identification



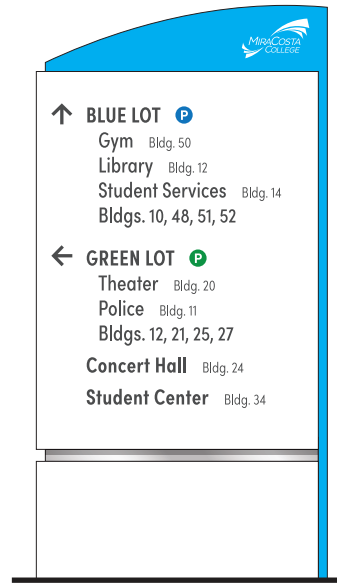
A7 - Secondary Freestanding Building Identification



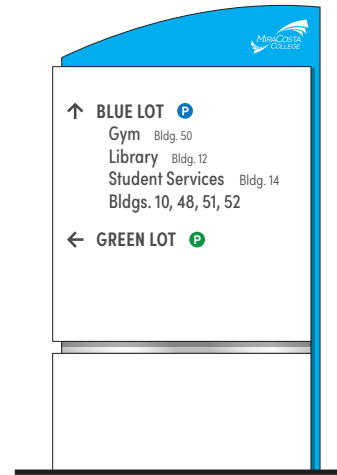
A8 - Primary Campus Monument



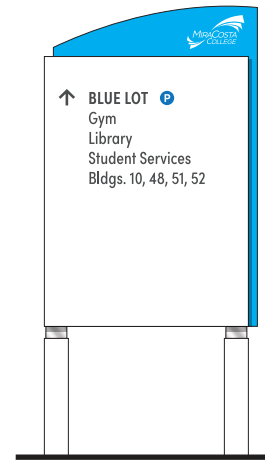
A9 - Secondary Campus Monument



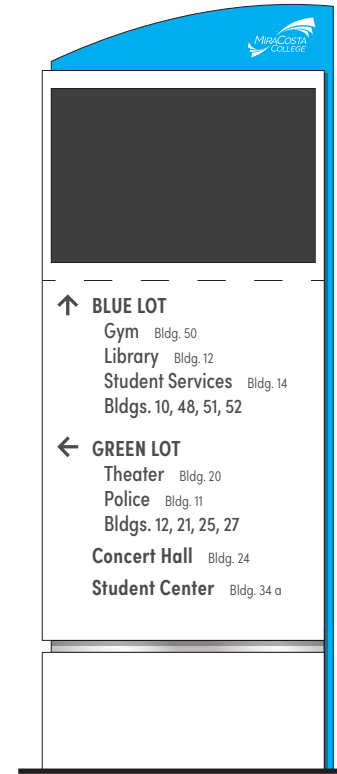
B1 - Primary Vehicular Directional



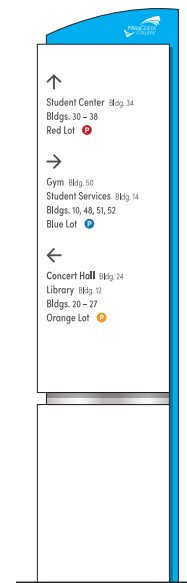
B2 - Secondary Vehicular Directional



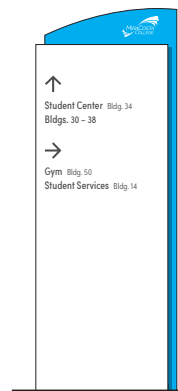
B3 - Tertiary Vehicular Directional



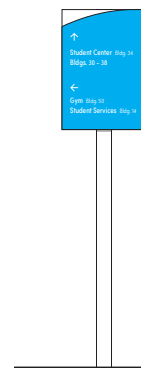
B4 - Vehicular Directional w/ LED Display



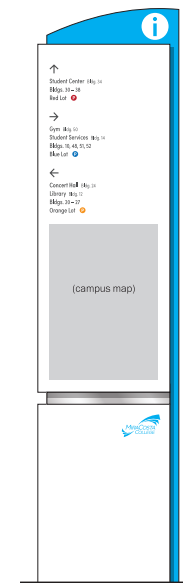
B5 - Primary Pedestrian Directional



B6 - Secondary Pedestrian Directional

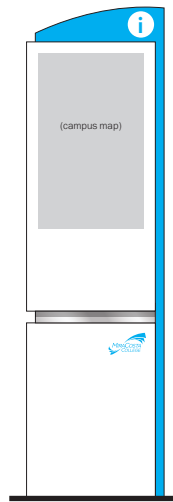


B7 - Tertiary Pedestrian Directional

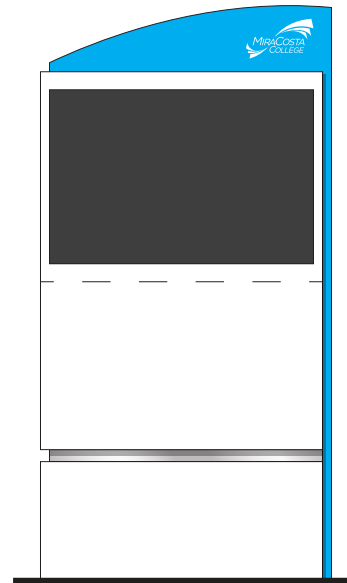


B8 - Pedestrian Directional w/ Campus Map

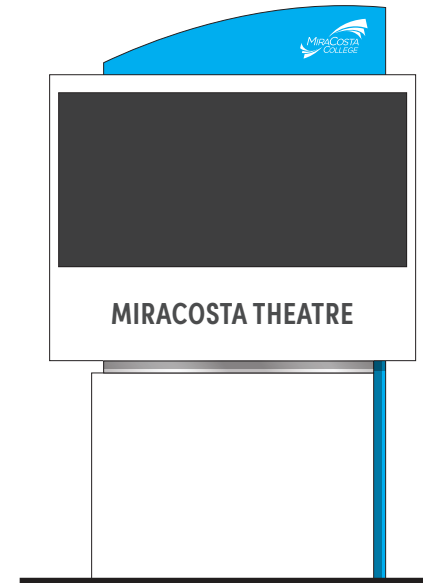
All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.



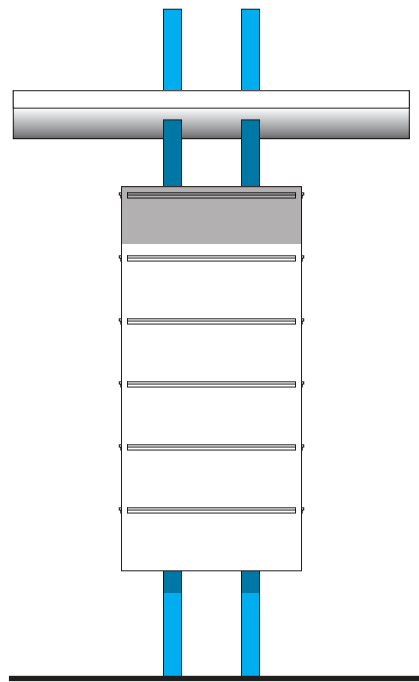
C1 - Campus Directory Map



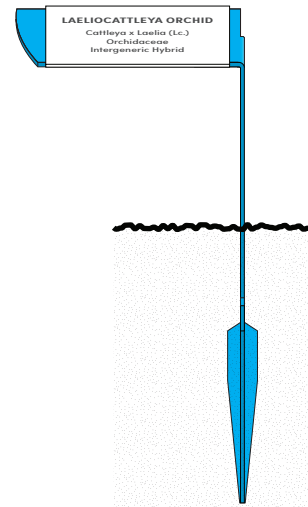
C2 - Freestanding Digital Display



C3 - Theatre Building Digital Marquee

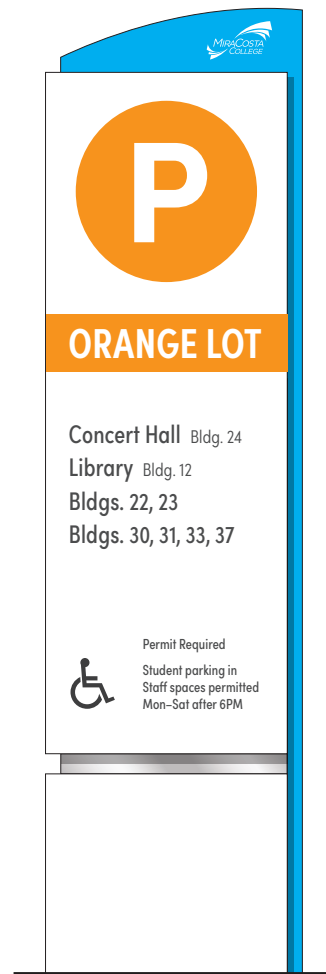


C4 - Information Bulletin Kiosk

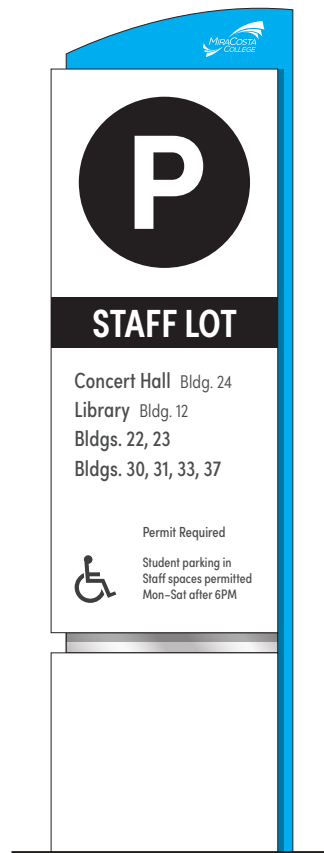


C5 - Plant Information Plaque

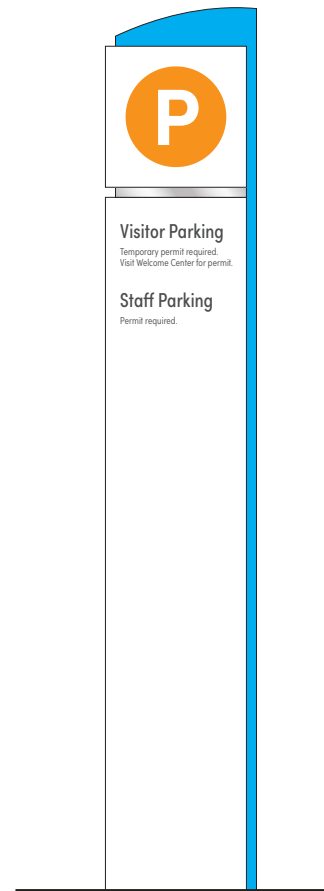
All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.



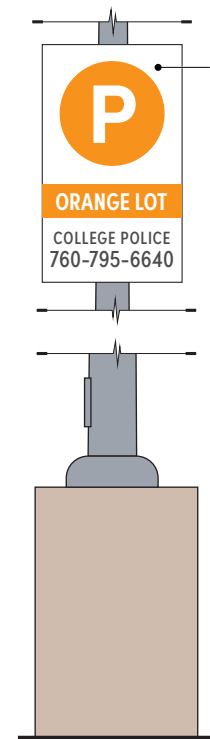
**P1 - Primary Parking Lot
Identification**



**P2 - Secondary Parking Lot
Identification**

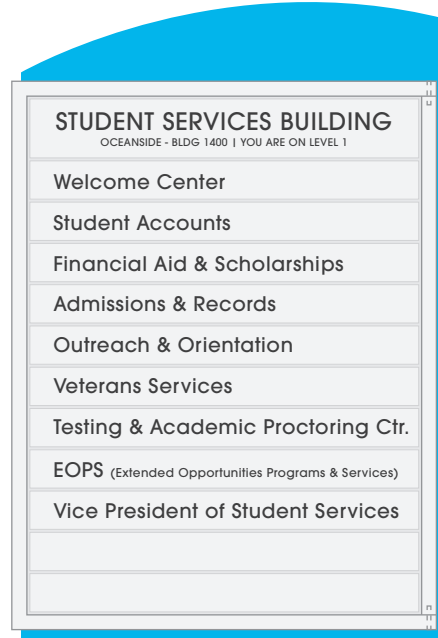


**P3 - Parking User Group
Identification**

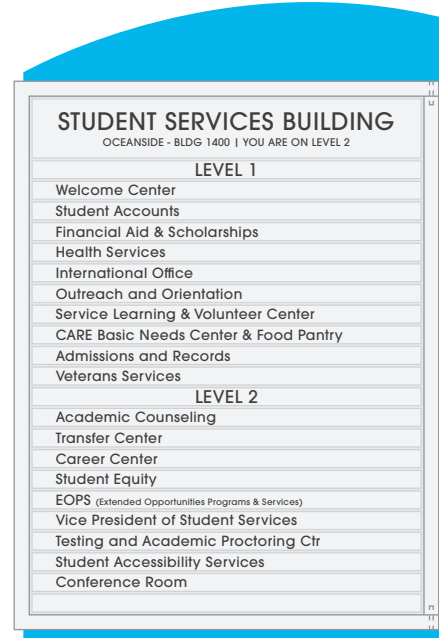


**P4 - Parking Lot Identification
(Light Pole Mounted)**

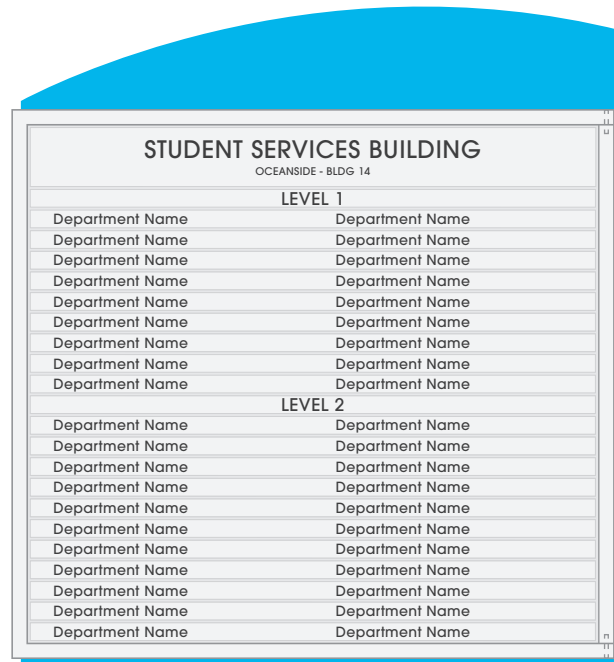
All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.



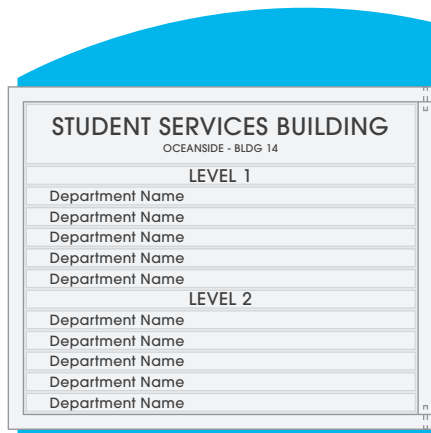
E1 - Department Directory



E2 - Building Directory Medium



E2.1 - Building Directory Large



E2.2 - Building Directory Small

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**

Oceanside, CA

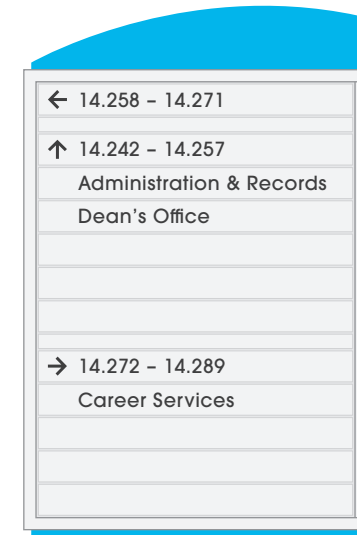
75-22602-00

July 18, 2023

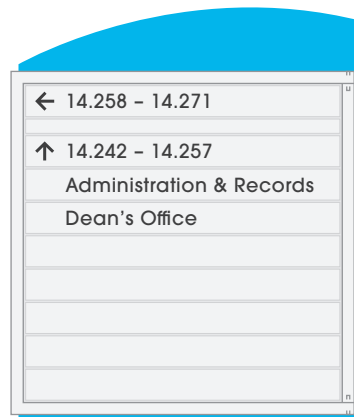
Preliminary Signage Standards Manual



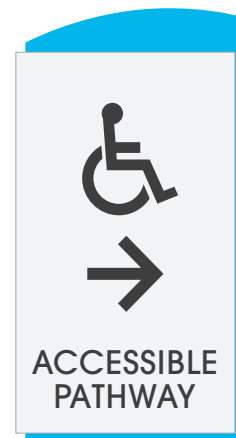
F3 - Blade Directional



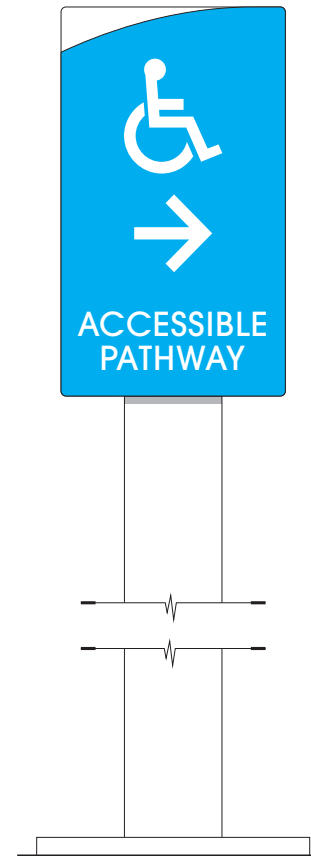
F4 - Corridor Directional (large)



F5 - Corridor Directional (small)



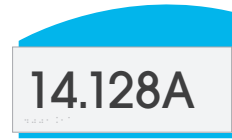
F6 - Accessible Directional
(Wall Mounted)



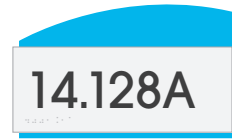
F7 - Accessible Directional
(Post Mounted)

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

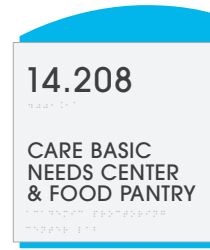
**SIGNAGE HIERARCHY
F SERIES SIGNAGE**



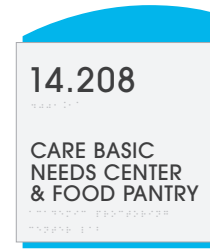
**G1 - ADA Room Number
Identification**
(Interior)



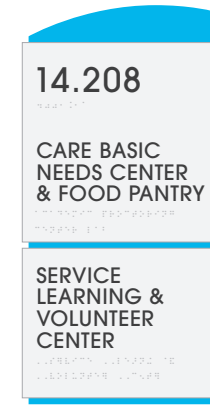
**G1.1 - ADA Room Number
Identification**
(Exterior)



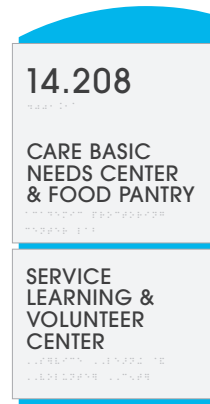
**G2 - ADA Permanent Room
Identification**
(Interior)



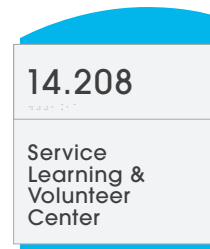
**G2.1 - ADA Permanent
Room Identification**
(Exterior)



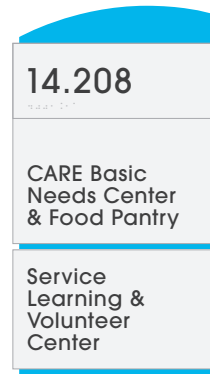
**G2.2 - ADA Permanent Room
Identification Large**
(Interior)



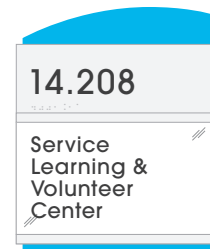
**G2.3 - ADA Permanent Room
Identification Large**
(Exterior)



**G3 - ADA Room
Identification**



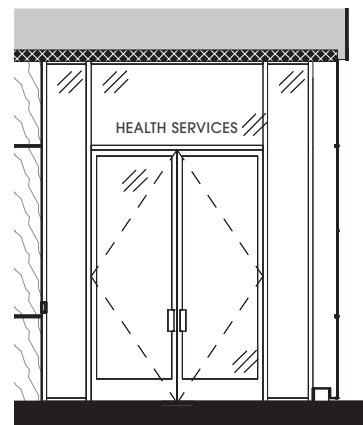
**G3.1 - ADA Room
Identification Large**



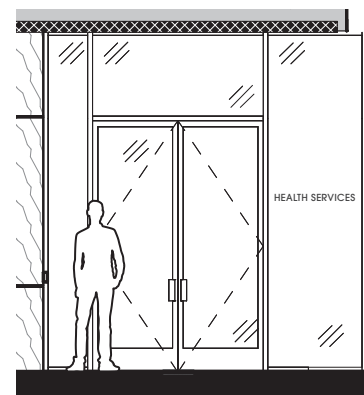
**G4 - ADA Room
Identification w/ Insert**



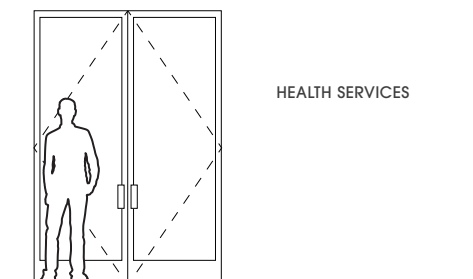
G5 - Identification Blade



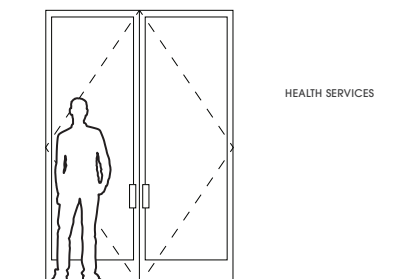
G6 - Department Identification Large
(Glass)



G6.1 - Department Identification Small
(Glass)



G7 - Department Identification Large
(Wall)



G7.1 - Department Identification Small
(Wall)

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

MiraCosta College District
Standards

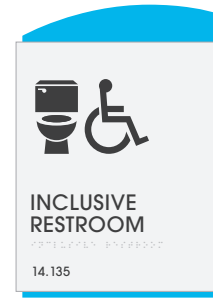
MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS
Oceanside, CA

75-22602-00
July 18, 2023

Preliminary Signage Standards Manual



H1 - Restroom Identification
(Interior)



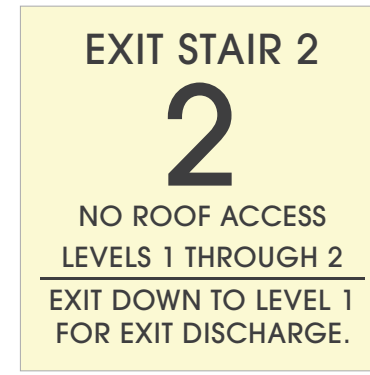
H1.1 - Restroom Identification
(Exterior)



H2 - Stair Identification
(Interior)



H2.1 - Stair Identification
(Exterior)



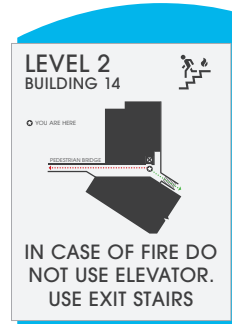
H3 - Interior Stairwell Identification



H4 - Stair Landing Identification



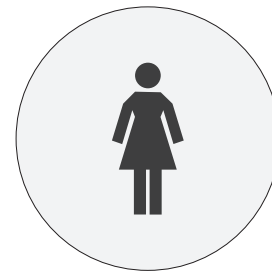
H5 - Elevator Egress Map
(Interior)



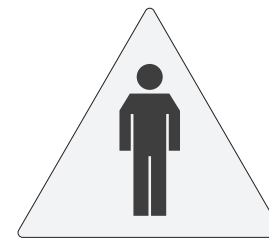
H5.1 - Elevator Egress Map
(Exterior)



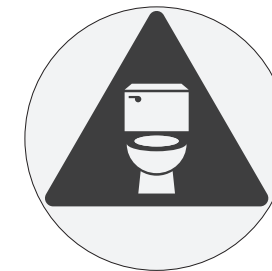
H6 - ADA Exit Identification



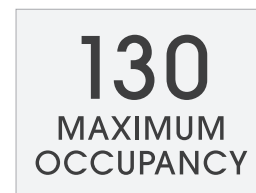
H7 - Women Restroom Identification
(Door Mount)



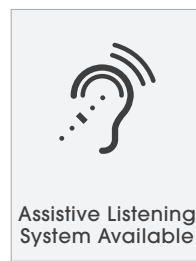
H8 - Men Restroom Identification
(Door Mount)



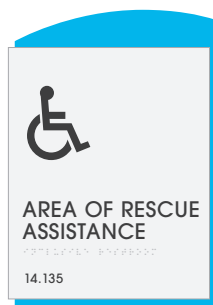
H9 - Restroom Identification
(Door Mount)



H10 - Maximum Occupancy



H11 - Assistive Listening System Notice



H12 - Area of Rescue Assistance/Refuge



J1 - No Smoking Decal
(Glass Mount)



J2 - No Smoking Notice
(Wall Mount)



J3 - No Food or Drink Notice
(Glass Mount)



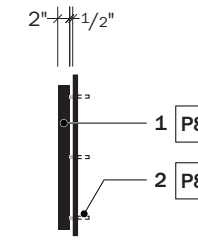
J4 - No Food or Drink Notice
(Wall Mount)

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

SIGNAGE HIERARCHY
H & J SERIES SIGNAGE

SECTION
04

Design Drawings

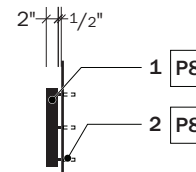


SIGN TYPE A1 - SIDE VIEW

SIGN TYPE A1 - FRONT VIEW
SCALE: 3/8" = 1'- 0"

DRAWING NOTES

- 1 Fabricated, aluminum letters with paint finish on all sides. Letters are mounted to wall with stainless metal back-pins. Sign fabricator to confirm with Architect, maximum embed depth for back-pins.
- 2 Stainless metal back-pins, attached to letters and embedded into mounting surface with epoxy as required to prevent detachment. Minimum 3-pins per letter required.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions. Review location indicated on plans to ensure that sign will fit as intended.
- B Sign Mfr. to develop and provide stamped engineering drawings that consider appropriate wind loads and sign weight. Connection method to be demonstrated in shop drawings.
- C Refer to signage message schedule for message per location.



SIGN TYPE A2 - SIDE VIEW

SIGN TYPE A2 - FRONT VIEW
SCALE: 3/8" = 1'- 0"

NOTE: MESSAGES INCLUDED ON THIS SHEET ARE FOR DEMONSTRATIVE PURPOSES ONLY. REFERENCE THE MESSAGE SCHEDULE FOR EACH BUILDING FOR ACCURATE MESSAGES.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPES A1 & A2
PRIMARY & SECONDARY
BUILDING IDENTIFICATION**

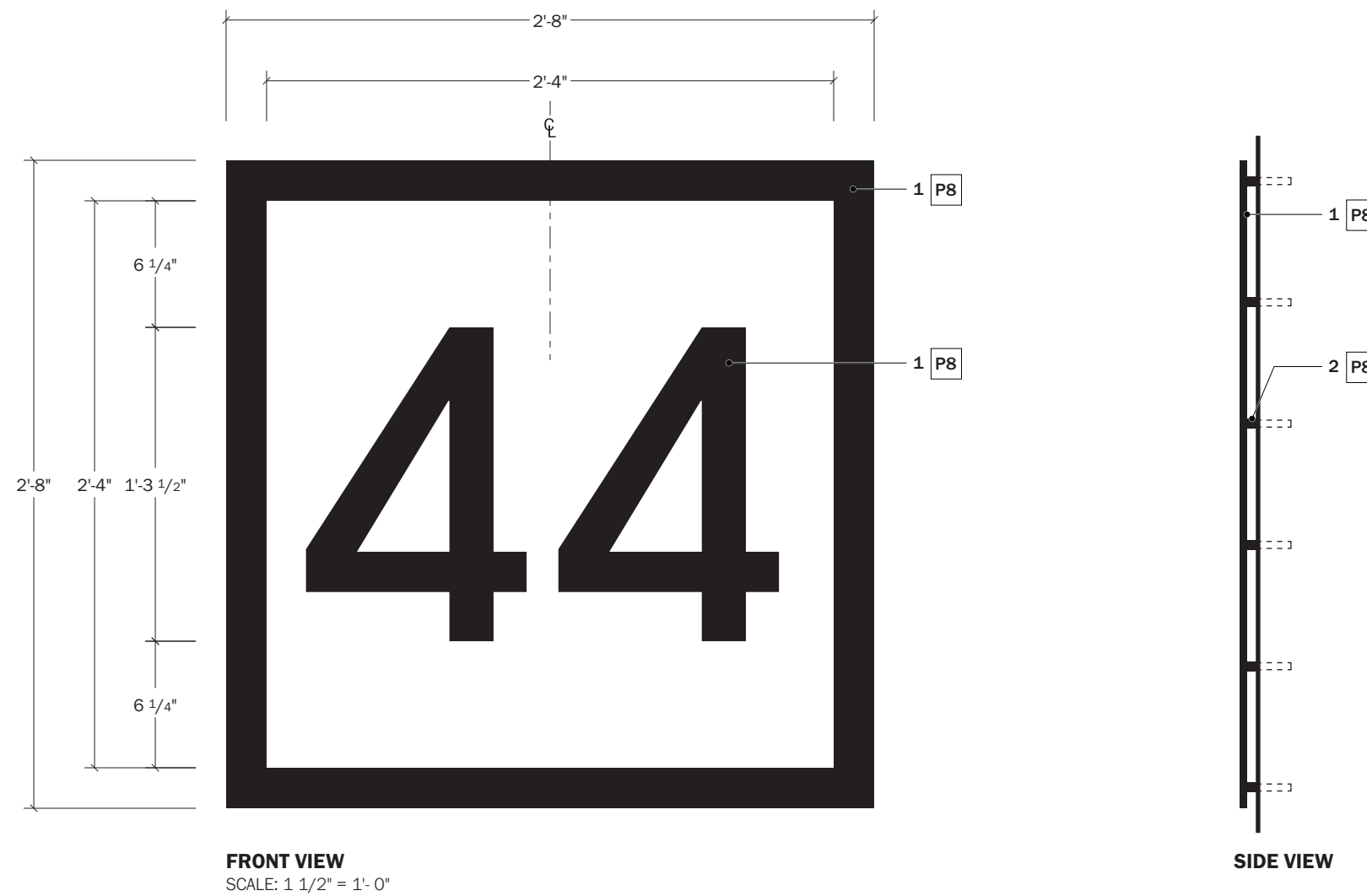


DRAWING NOTES

- 1 Fabricated open-channel logo letters with paint finish. Letters have concealed, premium-quality, white LEDs to create even halo-glow illumination effect around each part. Letters are pin-mounted off wall with stainless metal, back-pins. Electrical to each letter to be concealed from view. Letter faces are opaque. Clear acrylic backer required to enclose letters on back-side to prevent insects and bird nesting. Weep holes required for each letter to allow for condensation drainage.
- 2 Fabricated open-channel logo parts with paint finish. Logo parts have concealed, premium-quality, white LEDs to create even halo-glow illumination effect around each part. parts are pin-mounted off wall with stainless metal, back-pins. Electrical to each part to be concealed from view. Logo part faces are opaque. Clear acrylic backer required to enclose logo parts on back-side to prevent insects and bird nesting. Weep holes required for each letter to allow for condensation drainage.
- 3 Stainless, metal back-pins secured to logo pieces and embedded into wall to prevent detachment. Sign fabricator to coordinate maximum embed depth allowed with Architect prior to shop drawings.
- A Sign fabricator to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B Sign fabricator to develop and provide stamped engineering drawings that consider appropriate wind loads and sign weight.
- C Sign fabricator required to develop and detail attachment to building in shop drawings for review.
- D Sign fabricator to coordinate electrical supply requirements, locations of connection points, and control switch.
- E Emergency shut-off switch to be made inconspicuous from front view.
- F Sign fabricator to coordinate with Owner if illumination is to be on a timer or photocell prior to shop drawings. Coordinate location of switch/timer/photocell with Architect and Owner prior to shop drawings.
- G All electrical components, transformers, wiring, etc. to be concealed from view. Sign fabricator responsible creating electrical diagrams and associated documentation for providing power to all parts of sign.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE A3
BUILDING LOGO**



DRAWING NOTES

- 1 3/8" thick, cut-out aluminum sign with paint finish on all sides. Sign parts are mounted to building facade with stainless metal back-pins.
 - 2 Stainless metal back-pins, attached to sign parts and embedded into mounting surface with epoxy as required to prevent detachment. Sign parts are mounted 1/2" from wall surface. Minimum 3-pins per letter/ sign part required. All penetrations to facade are to be water-proofed.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions. Review location indicated on plans to ensure that sign will fit as intended.
- B Sign Mfr. to develop and provide stamped engineering drawings that consider appropriate wind loads and sign weight. Connection method to be demonstrated in shop drawings.
- C Refer to signage message schedule for message per location.

NOTE: MESSAGES INCLUDED ON THIS SHEET ARE FOR DEMONSTRATIVE PURPOSES ONLY. REFERENCE THE MESSAGE SCHEDULE FOR EACH BUILDING FOR ACCURATE MESSAGES.

THIS STANDARDS PACKAGES UTILIZES A NEW BUILDING AND ROOM NUMBERING SYSTEM TO BE IMPLEMENTED BY THE COLLEGE AT A FUTURE DATE.

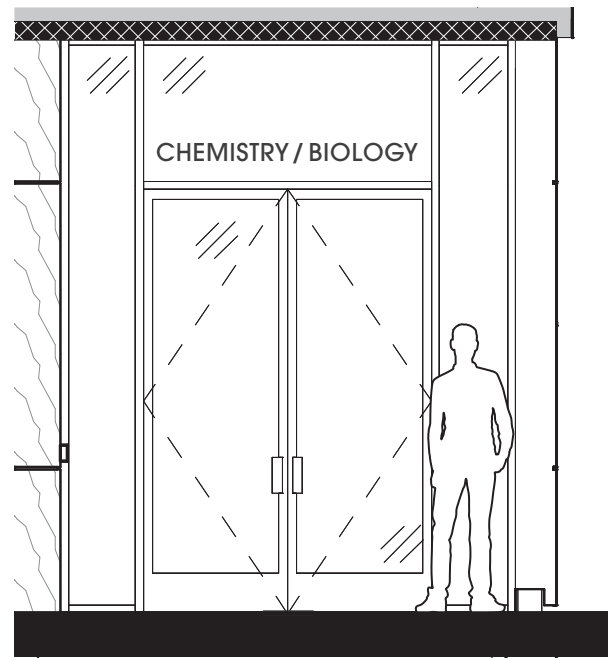
THIS SIGN TYPE MAY NOT BE APPLICABLE UNTIL NEW SYSTEM IS IMPLEMENTED.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

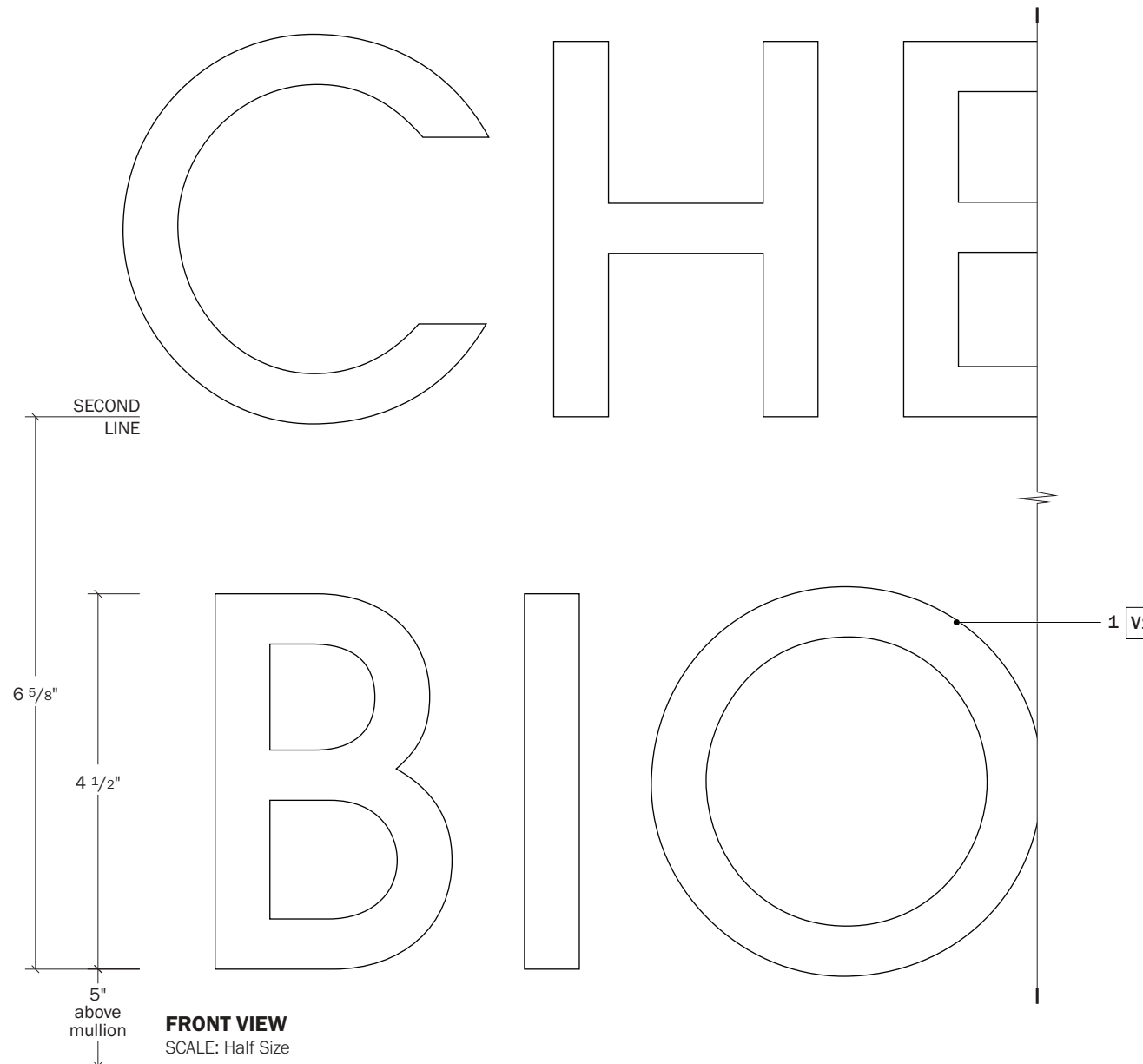
**SIGN TYPE A4
BUILDING NUMBER
IDENTIFICATION**

DRAWING NOTES

- 1 Applied vinyl lettering on first surface of glass. Letters are applied level, and free of air bubbles, creases, folds and tears.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions. Review location indicated on plans to ensure that sign will fit as intended.
- B Refer to signage message schedule for message per location.
- C This sign type is intended to always be mounted to a glass surface.



MOUNTING ELEVATION
SCALE: 1/4" = 1'-0"



FRONT VIEW
SCALE: Half Size

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE A5
TERTIARY BUILDING
IDENTIFICATION**

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**

Oceanside, CA

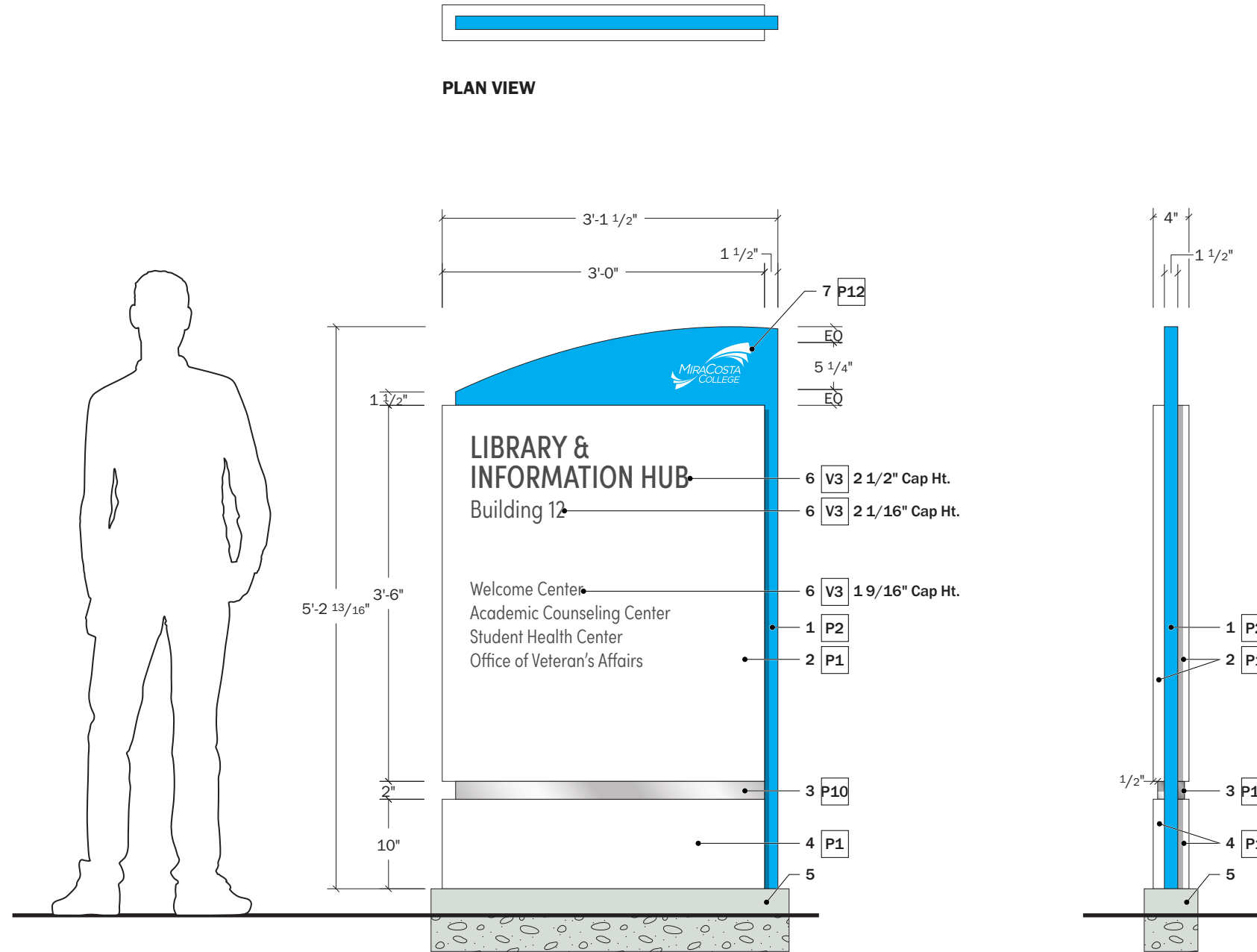
75-22602-00

July 18, 2023

Preliminary Signage Standards Manual

DRAWING NOTES

- 1 Fabricated aluminum sign fin w/ internal rigid framing structure and paint finish on all sides. Curvature at top of fin to be the same for all versions of this sign type.
- 2 Fabricated aluminum sign message panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns. Paint fasteners to match sign panel.
- 3 Fabricated reveal w/ paint finish. Reveal to abut to surrounding sign components with no gaps.
- 4 Fabricated aluminum sign footer panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns to provide maintenance access to footing connection. Paint fasteners to match sign panel.
- 5 Concrete footing as required per Sign Fabricator's engineering. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
- 6 Applied, premium grade vinyl lettering and symbols as noted. Vinyl is applied free of air bubbles, tears, folds, and creases.
- 7 Masked and painted logo.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.



PLAN VIEW

FRONT VIEW
SCALE: 3/4" = 1'-0"

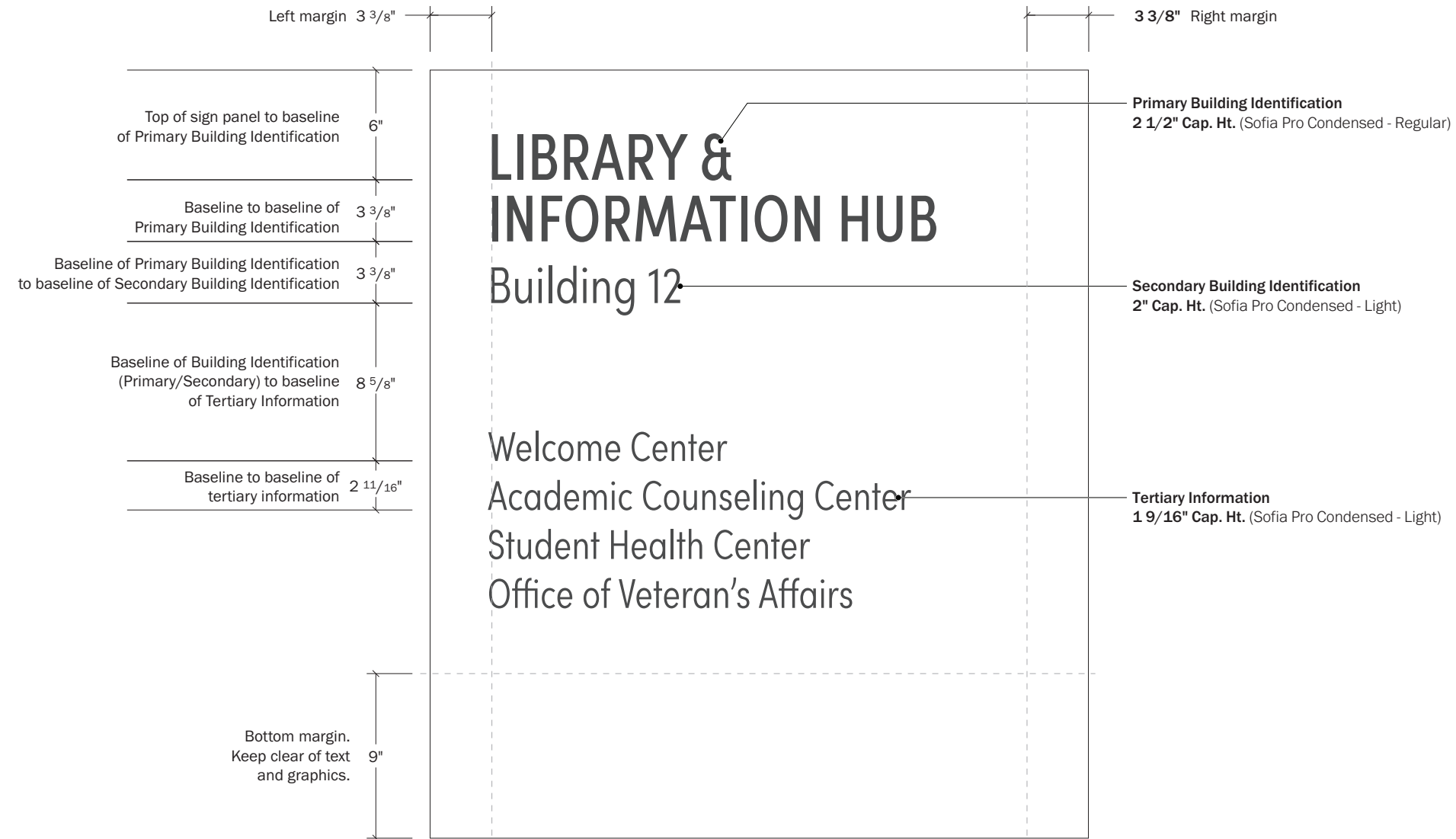
SIDE VIEW

THIS SIGN TYPE AND SEVERAL OTHERS IN THE FOLLOWING STANDARDS MANUAL UTILIZE A NEW BUILDING AND ROOM NUMBERING SYSTEM TO BE IMPLEMENTED BY THE COLLEGE AT A FUTURE DATE.

IF SIGNS ARE INSTALLED PRIOR TO NUMBERING SYSTEM IMPLEMENTATION, BUILDING AND ROOM NUMBERS SHOULD BE UPDATED AND SIGNS REPLACED AS NEEDED TO FIT INTO THE SYSTEM.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE A6
PRIMARY FREESTANDING
BUILDING IDENTIFICATION**

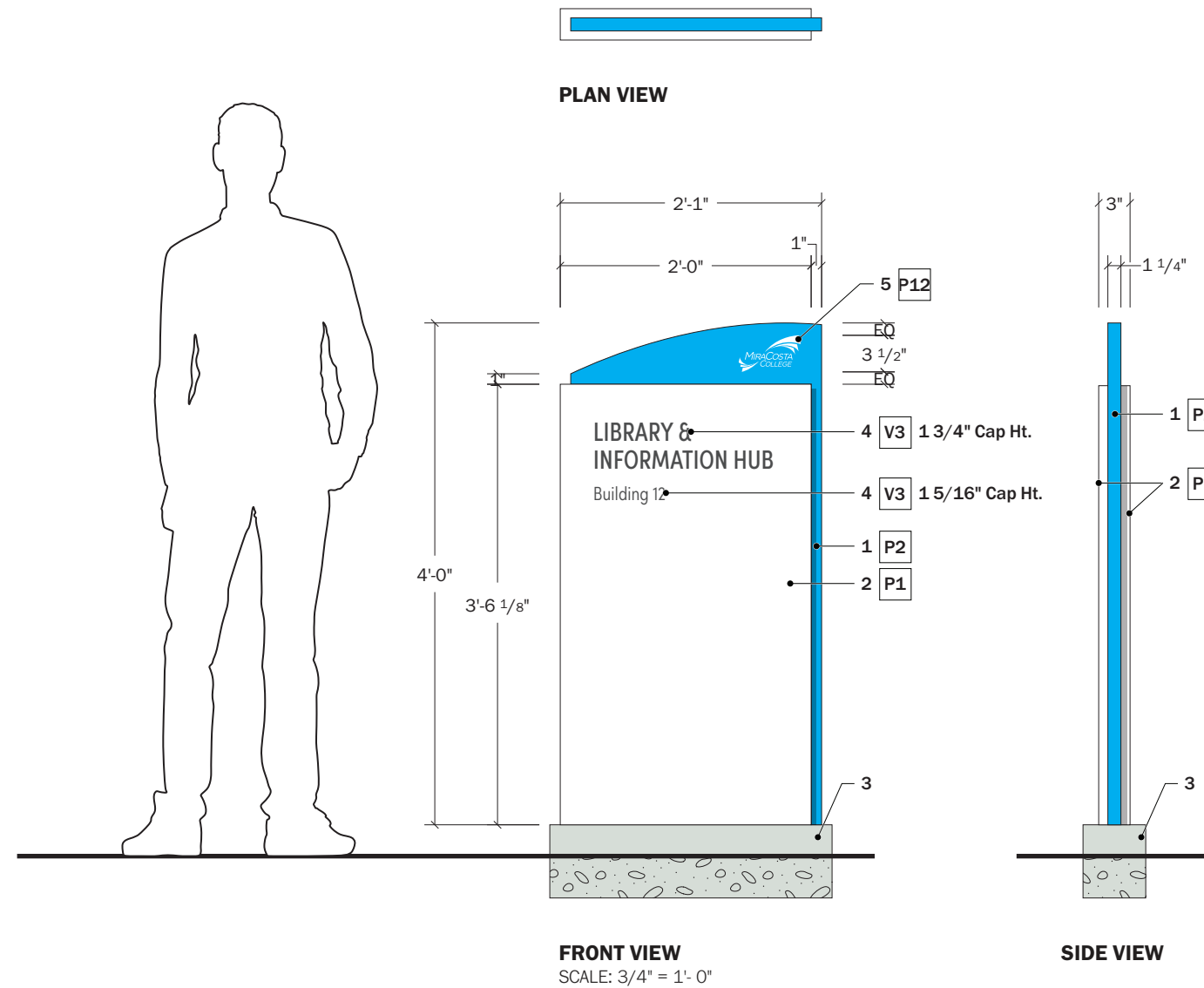


FRONT VIEW
SCALE: 3/4" = 1'- 0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

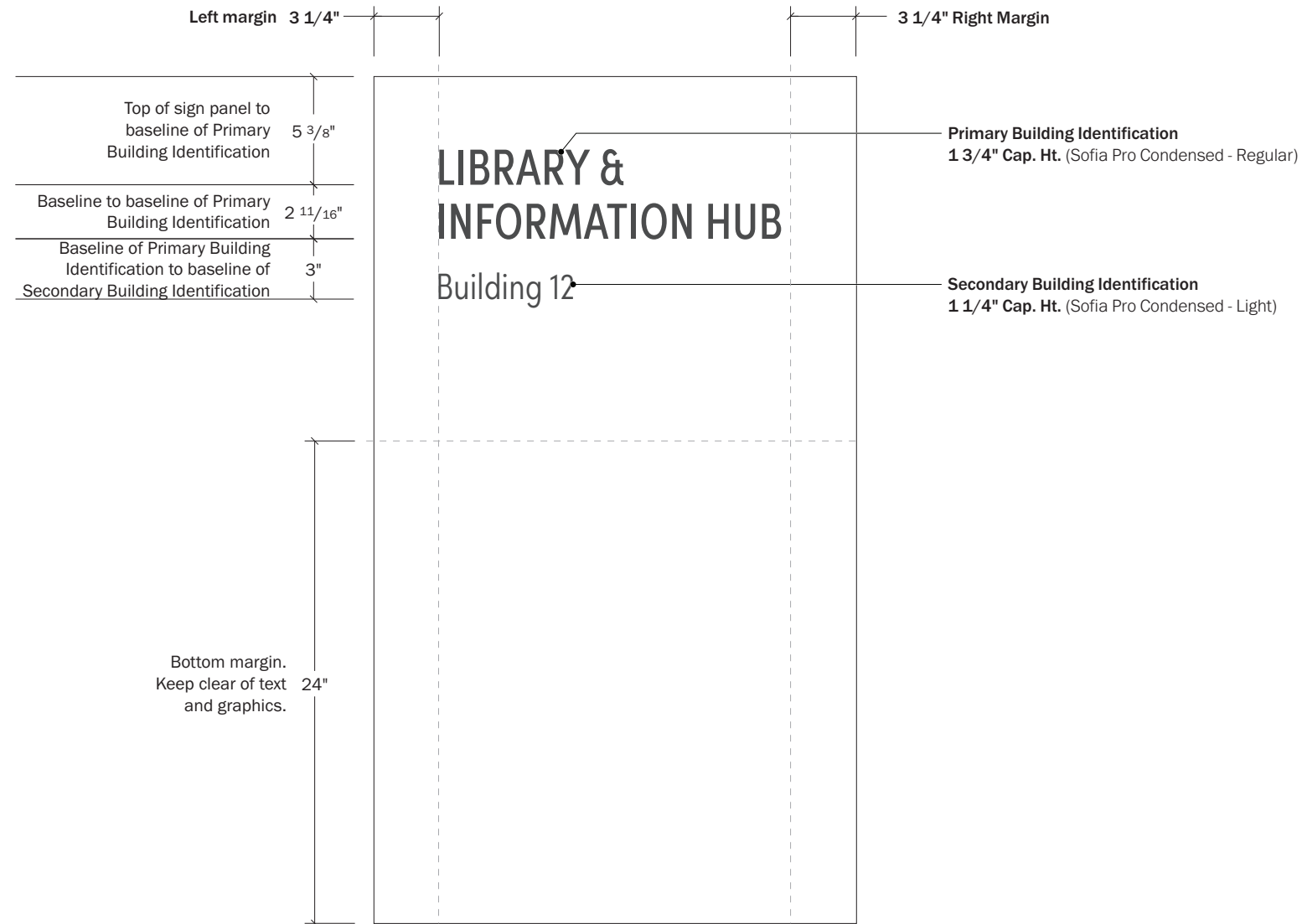
DRAWING NOTES

- 1 Fabricated aluminum sign fin w/ internal rigid framing structure and paint finish on all sides. Curvature at top of fin to be the same for all versions of this sign type.
 - 2 Fabricated aluminum sign message panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns to provide maintenance access to footer connection. Paint fasteners to match sign panel.
 - 3 Concrete footing as required per Sign Fabricator's engineering. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
 - 4 Applied, premium grade vinyl lettering and symbols as noted. Vinyl is applied free of air bubbles, tears, folds, and creases.
 - 5 Masked and painted logo.
- A** Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B** Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.



All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE A7
SECONDARY FREESTANDING
BUILDING IDENTIFICATION**



PANEL LAYOUT DIMENSIONS
SCALE: 1 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

DESIGN IN PROGRESS

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE A8
PRIMARY CAMPUS
MONUMENT**

MiraCosta College District
Standards

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

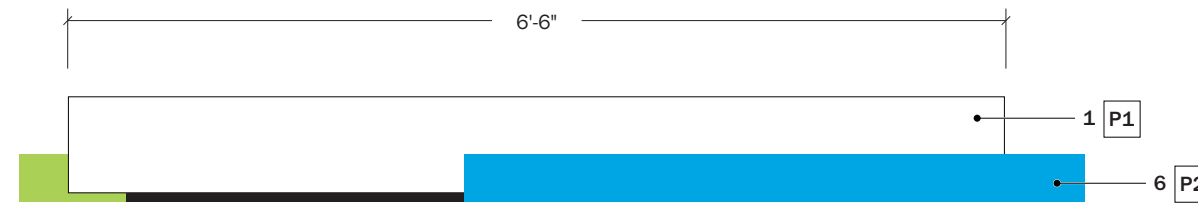
Preliminary Signage Standards Manual

DRAWING NOTES

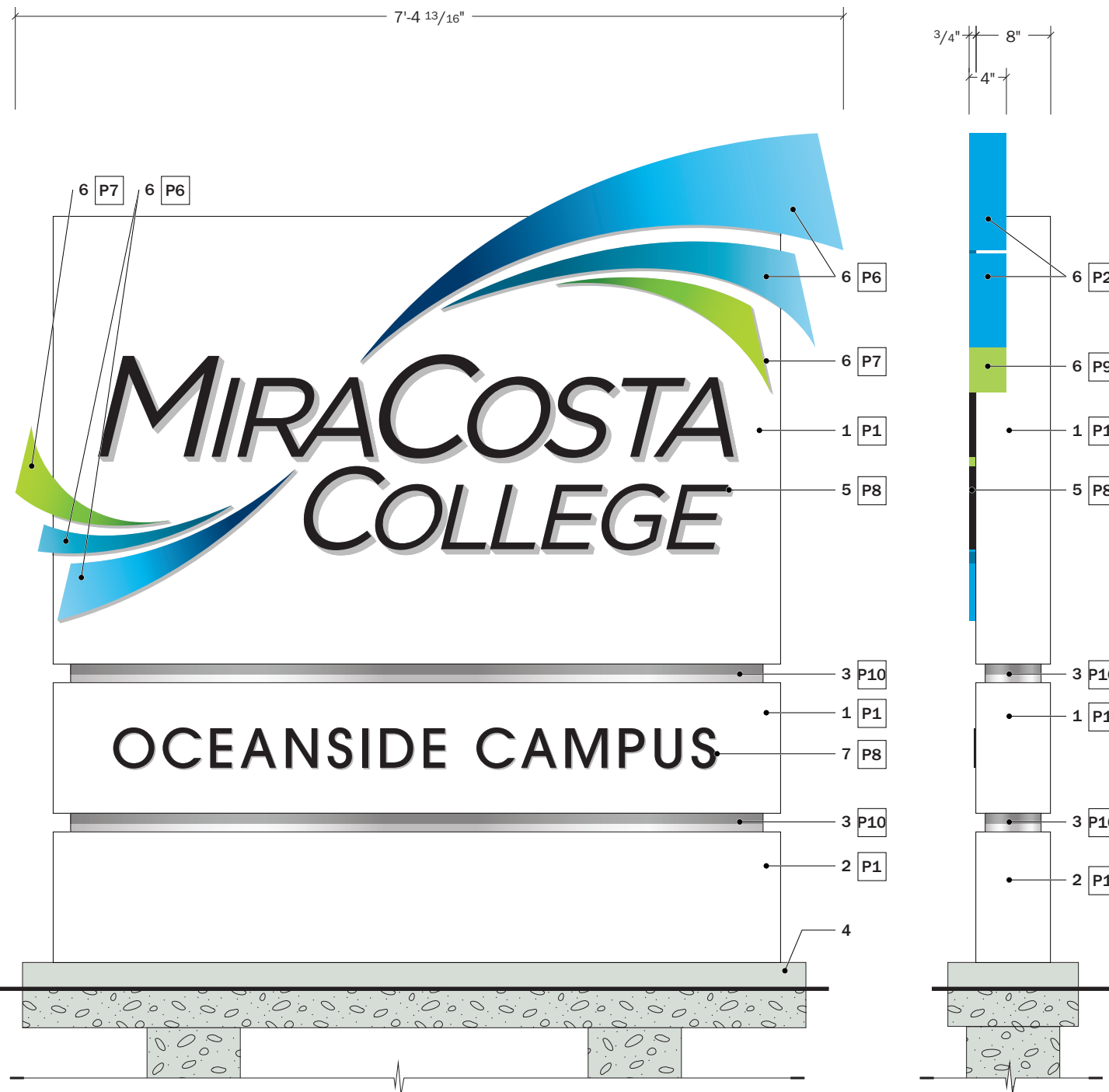
- 1 Fabricated sign cabinet with internal rigid structure to prevent warping/oil-canning. Cabinet has paint finish on all sides. Cabinet to host LED lighting and electrical components for logo/campus identification lettering.
 - 2 Fabricated aluminum sign footer panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel are removable via tamper-proof, flathead mechanical fasteners on sign returns to provide maintenance access to footing connection. Paint fasteners to match sign panel.
 - 3 Fabricated reveal w/ paint finish. Reveal to abut to surrounding sign components with no gaps.
 - 4 Concrete footing as required per Sign Fabricator's engineering. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
 - 5 3/4" Thick, clear acrylic, push-thru logo letters with opaque, painted faces to block light. Letters are back-lit with premium quality, warm white LED lights to provide halo-glow effect.
 - 6 Fabricated logo pieces with interior illumination, printed vinyl applied over acrylic faces and painted returns and trim-caps. Pieces are illuminated with Bitro Cool Blue LEDs. Fabricator to consult Bitro for LED layout to ensure even illumination, dimming, and light temperature. Pieces are secured to sign cabinet with electrical components concealed within.
 - 7 1/4" Thick, clear acrylic, push-thru campus identification letters with opaque, painted faces to block light. Letters are back-lit with premium quality, warm white LED lights to provide halo-glow effect.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE A9
SECONDARY CAMPUS
MONUMENT**

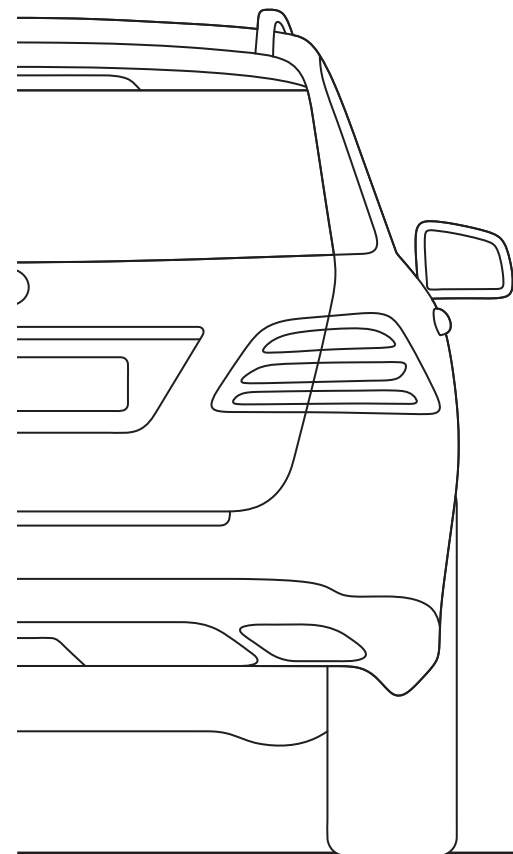


PLAN VIEW



FRONT VIEW
SCALE: 3/4" = 1'-0"

SIDE VIEW



MiraCosta College District
Standards

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

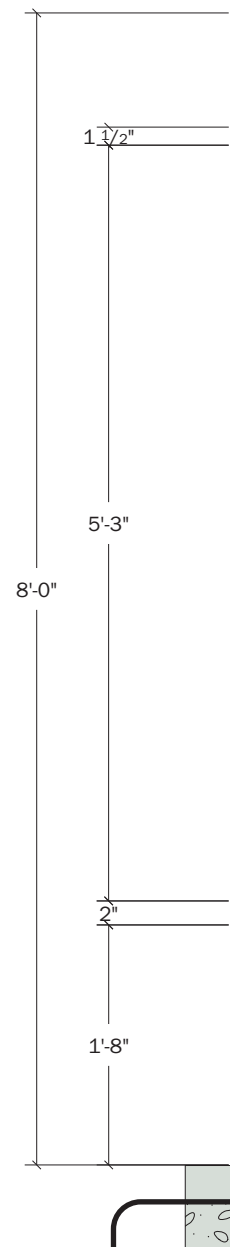
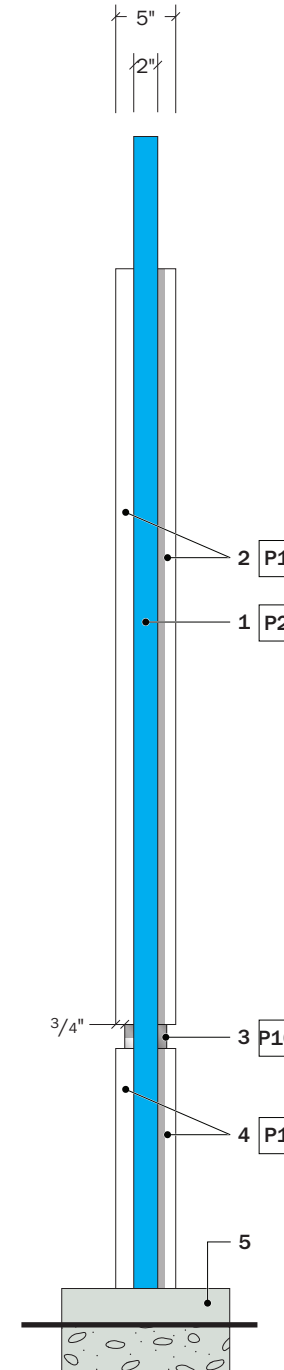
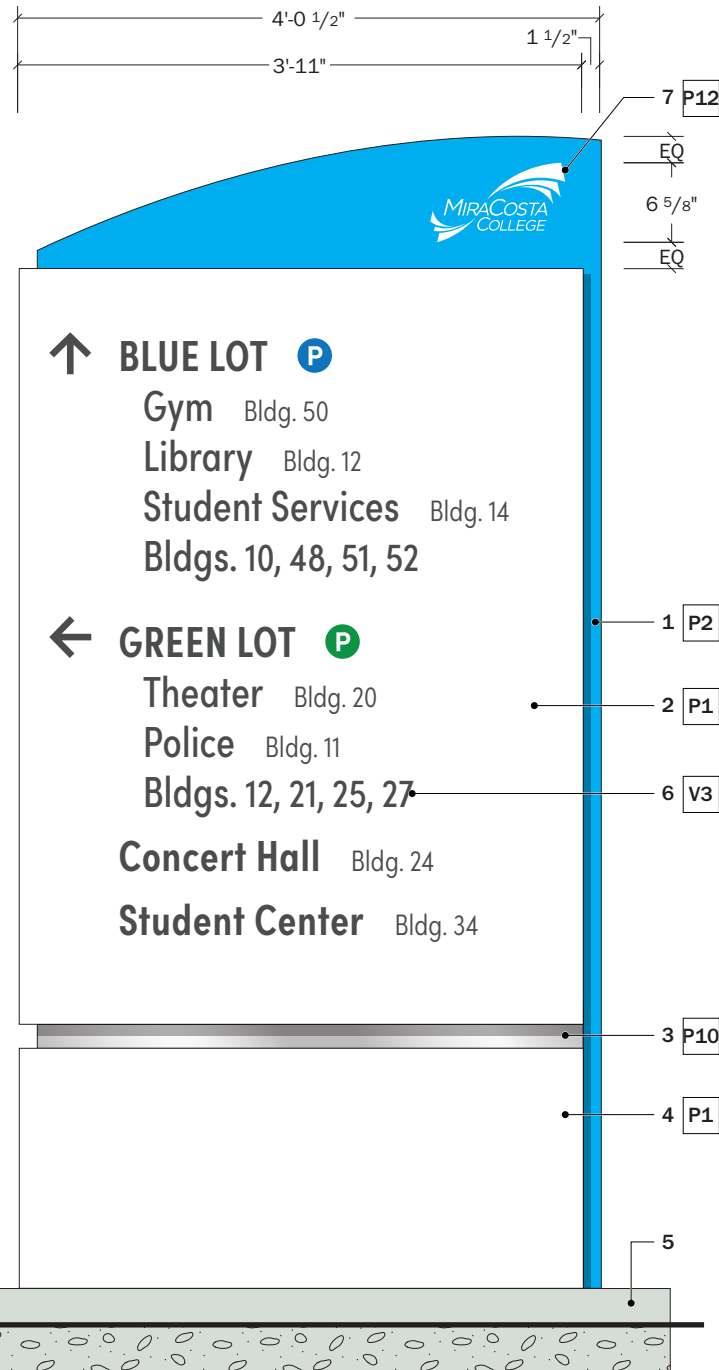
75-22602-00
July 18, 2023

Preliminary Signage Standards Manual

DRAWING NOTES

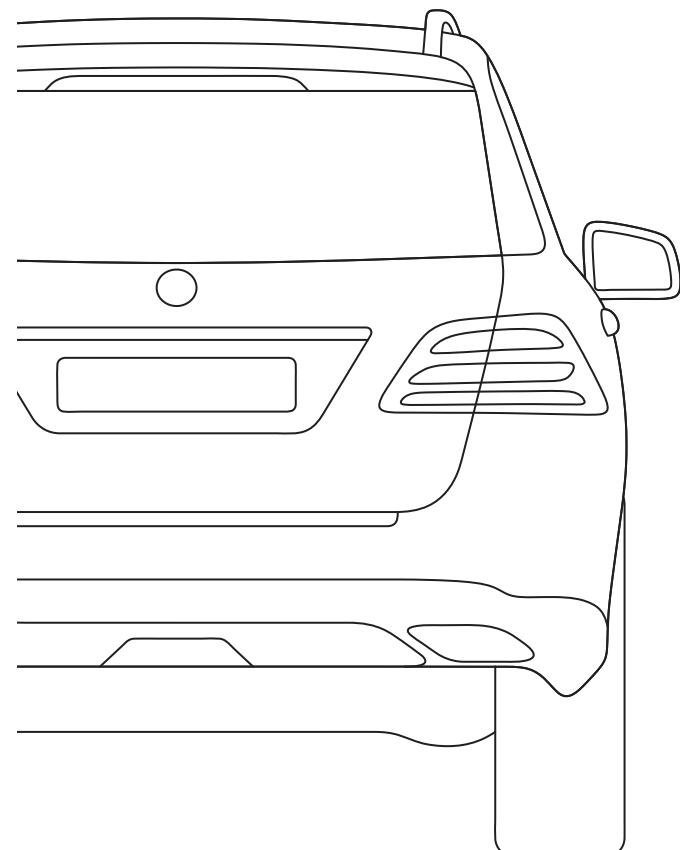
- 1 Fabricated aluminum sign fin w/ internal rigid framing structure and paint finish on all sides. Curvature at top of fin to be the same for all versions of this sign type.
 - 2 Fabricated aluminum sign message panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns. Paint fasteners to match sign panel.
 - 3 Fabricated reveal w/ paint finish. Reveal to abut to surrounding sign components with no gaps.
 - 4 Fabricated aluminum sign footer panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns to provide maintenance access to footing connection. Paint fasteners to match sign panel.
 - 5 Concrete footing as required per Sign Fabricator's engineering. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
 - 6 Applied, premium grade vinyl lettering and symbols as noted. Vinyl is applied free of air bubbles, tears, folds, and creases.
 - 7 Masked and painted logo.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.

PLAN VIEW



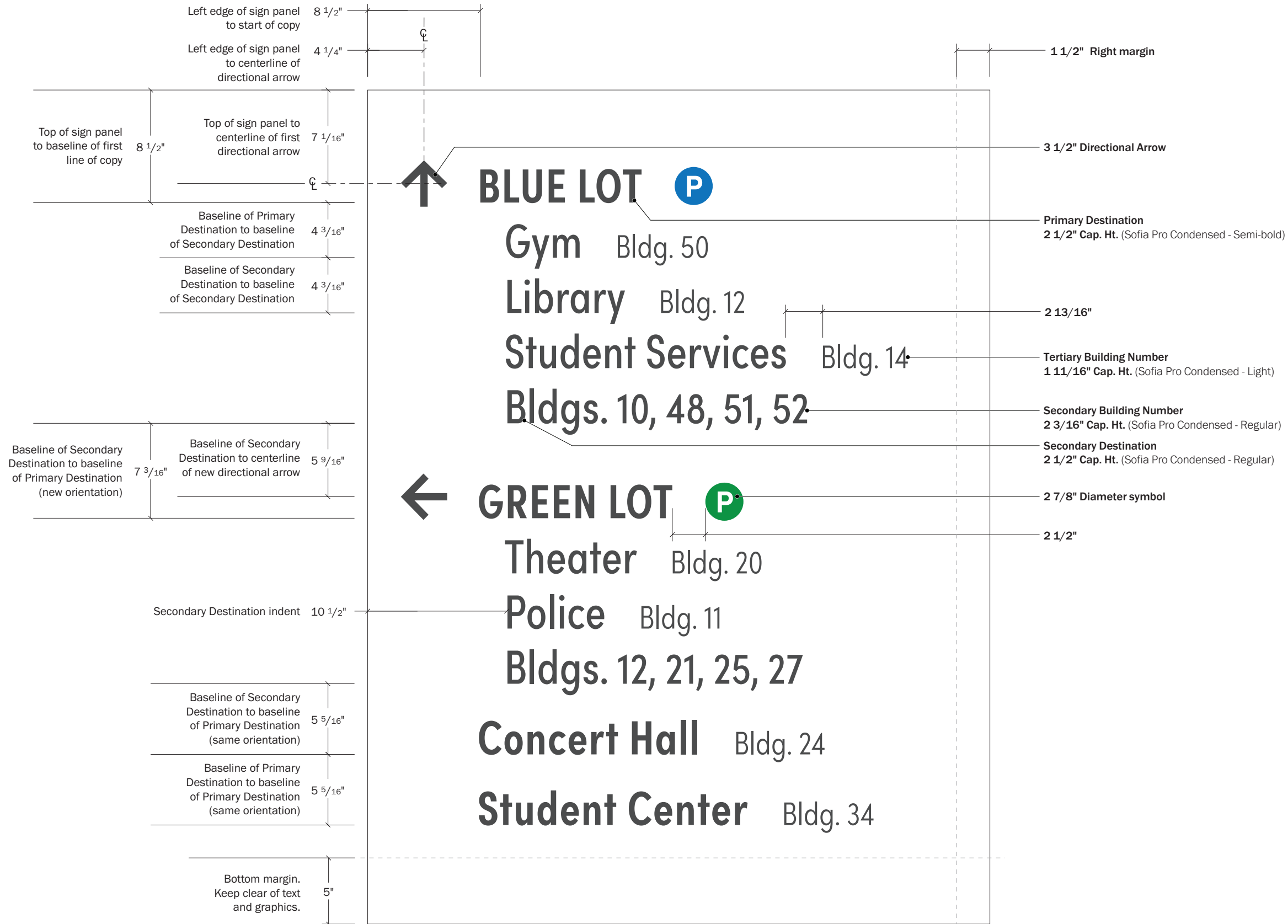
FRONT VIEW
SCALE: 3/4" = 1'- 0"

SIDE VIEW



All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE B1
PRIMARY VEHICULAR
DIRECTIONAL**



PANEL LAYOUT DIMENSIONS
SCALE: 1 1/2" = 1'-0"

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MiraCosta College District
Standards

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

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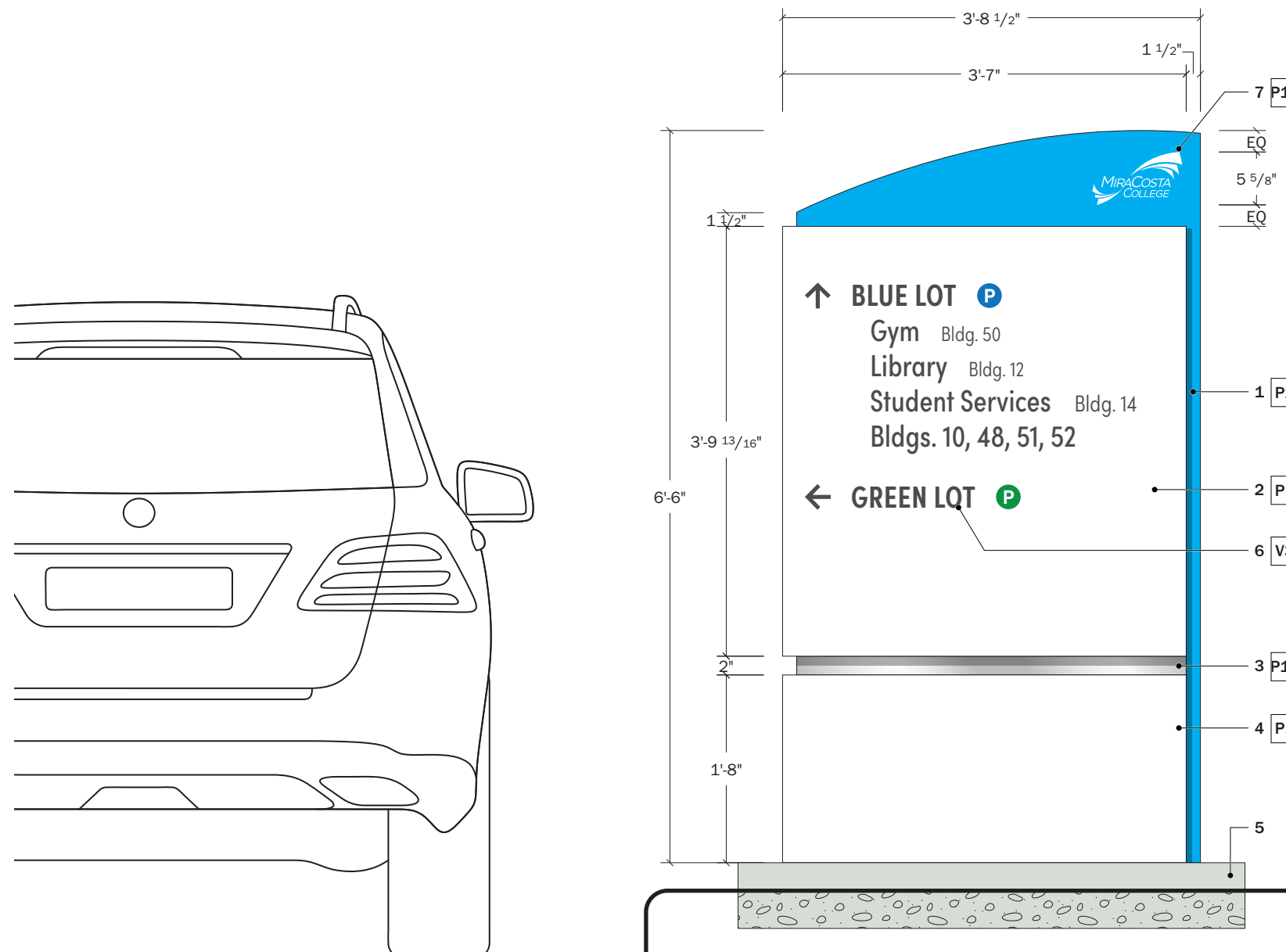
Preliminary Signage Standards Manual

DRAWING NOTES

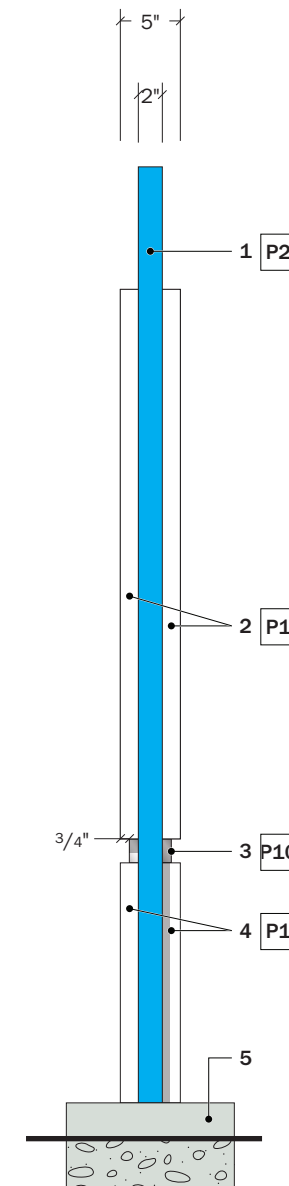
- 1 Fabricated aluminum sign fin w/ internal rigid framing structure and paint finish on all sides. Curvature at top of fin to be the same for all versions of this sign type.
 - 2 Fabricated aluminum sign message panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns. Paint fasteners to match sign panel.
 - 3 Fabricated reveal w/ paint finish. Reveal to abut to surrounding sign components with no gaps.
 - 4 Fabricated aluminum sign footer panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns to provide maintenance access to footing connection. Paint fasteners to match sign panel.
 - 5 Concrete footing as required per Sign Fabricator's engineering. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
 - 6 Applied, premium grade vinyl lettering and symbols as noted. Vinyl is applied free of air bubbles, tears, folds, and creases.
 - 7 Masked and painted logo.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.



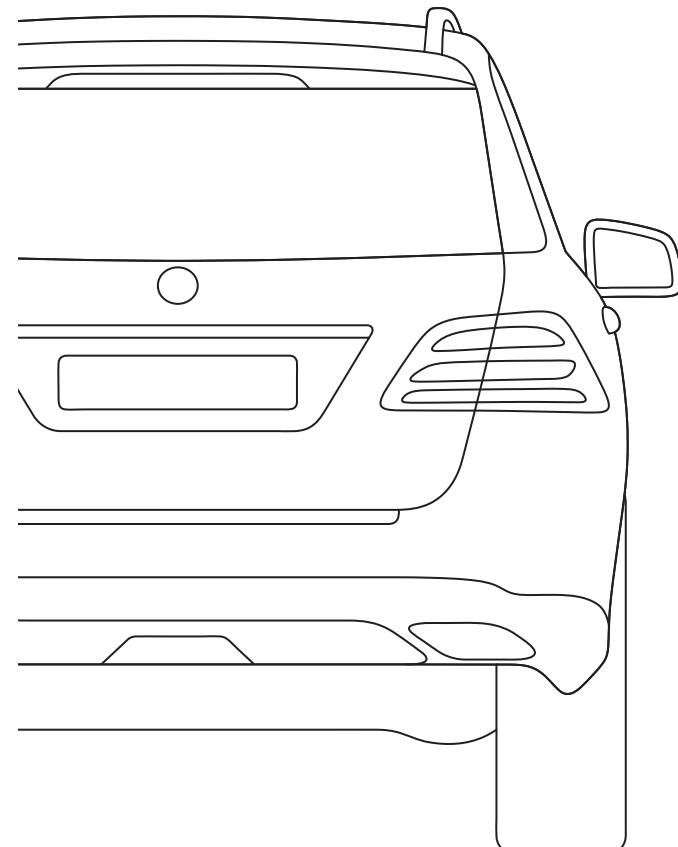
PLAN VIEW



FRONT VIEW
SCALE: 3/4" = 1'-0"

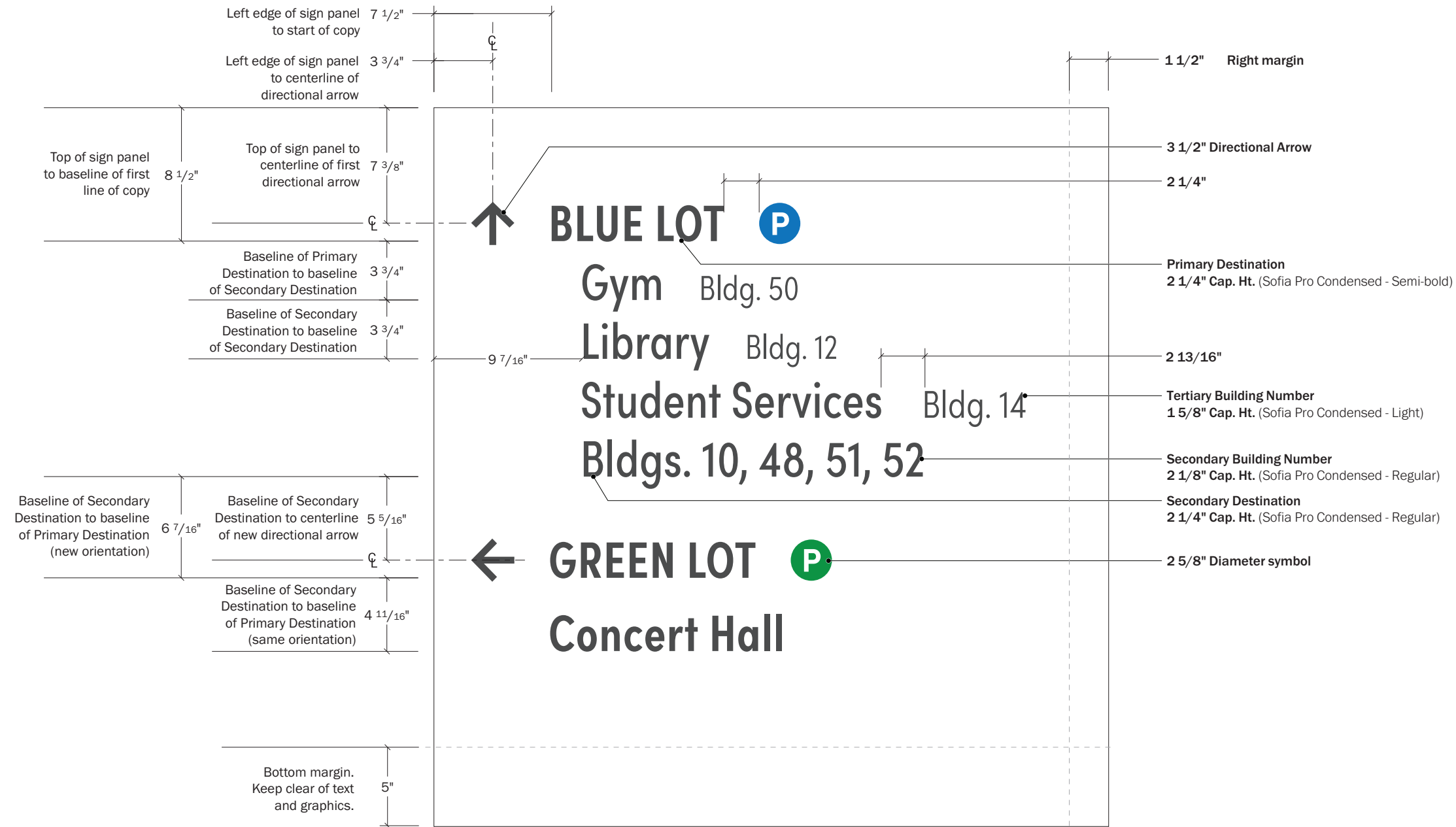


SIDE VIEW



All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE B2
SECONDARY VEHICULAR
DIRECTIONAL**

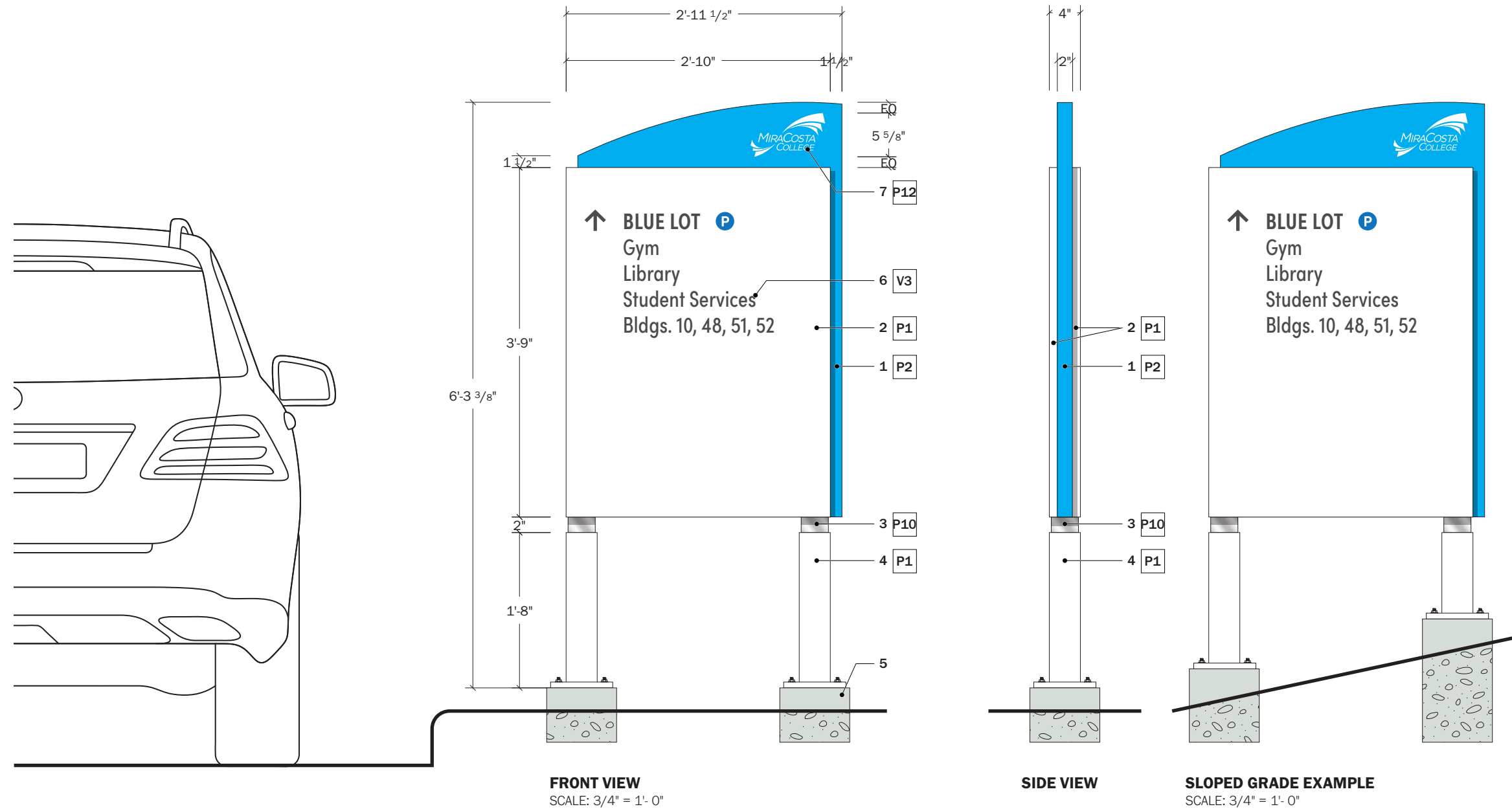


PANEL LAYOUT DIMENSIONS
SCALE: 1 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

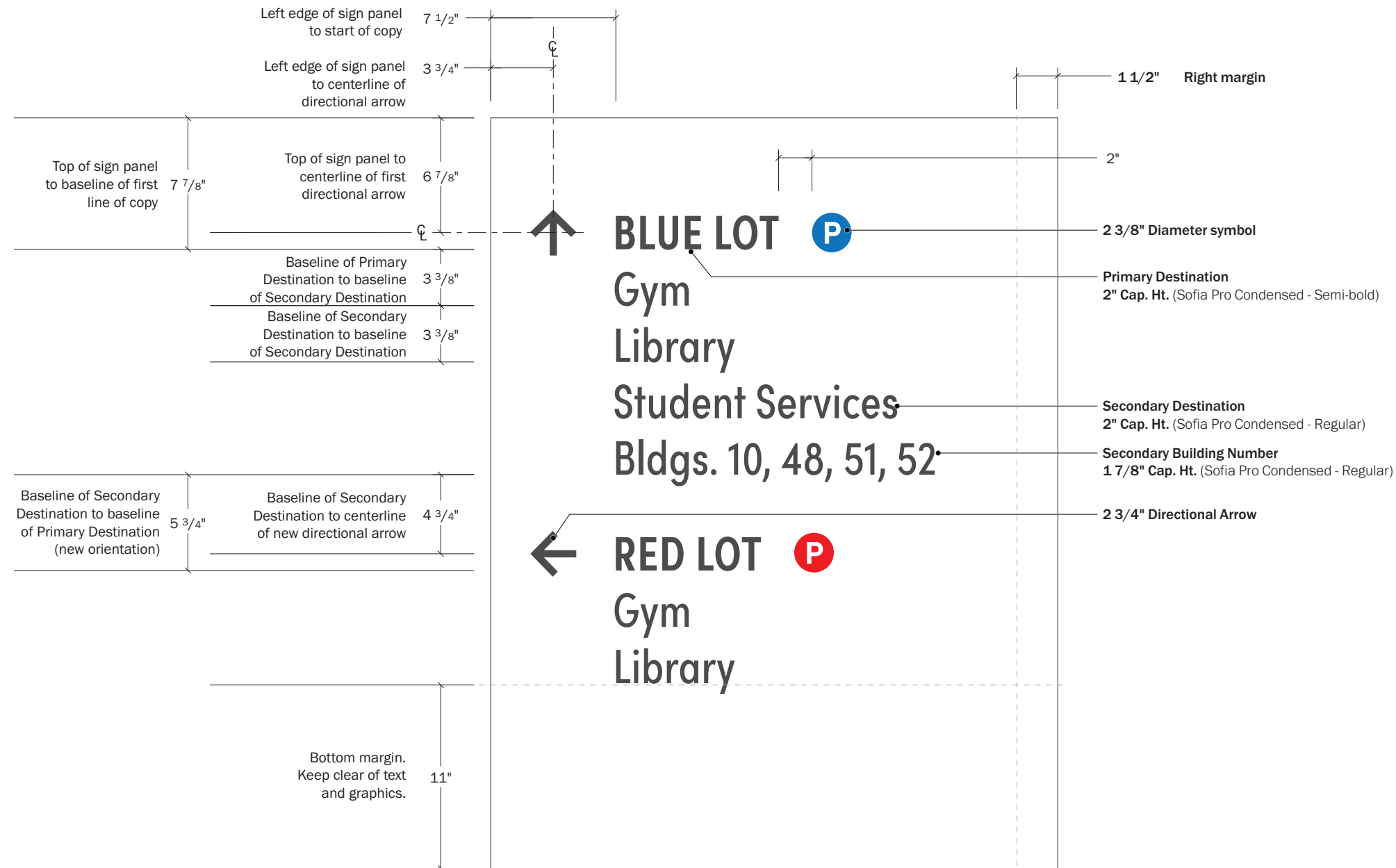
DRAWING NOTES

- 1 Fabricated aluminum sign fin w/ internal rigid framing structure and paint finish on all sides. Curvature at top of fin to be the same for all versions of this sign type.
- 2 Fabricated aluminum sign message panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns. Paint fasteners to match sign panel.
- 3 3 1/2" Fabricated reveal w/ paint finish. Reveal to abut to surrounding sign components with no gaps.
- 4 4" O.D. square metal posts with paint finish. Posts secure into footing with mechanical fasteners and mounting plates. Sign fabricator to engineer and develop as necessary. Posts may require different lengths depending on grade slope in order to maintain level -- field verify all locations prior to shop drawings to inspect grade at location. Posts should never be buried and connection to footing should always be accessible.
- 5 Concrete footing as required per Sign Fabricator's engineering. Footing has embedded mounting J-bolts to secure sign to. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
- 6 Applied, premium grade vinyl lettering and symbols as noted. Vinyl is applied free of air bubbles, tears, folds, and creases.
- 7 Masked and painted logo.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.



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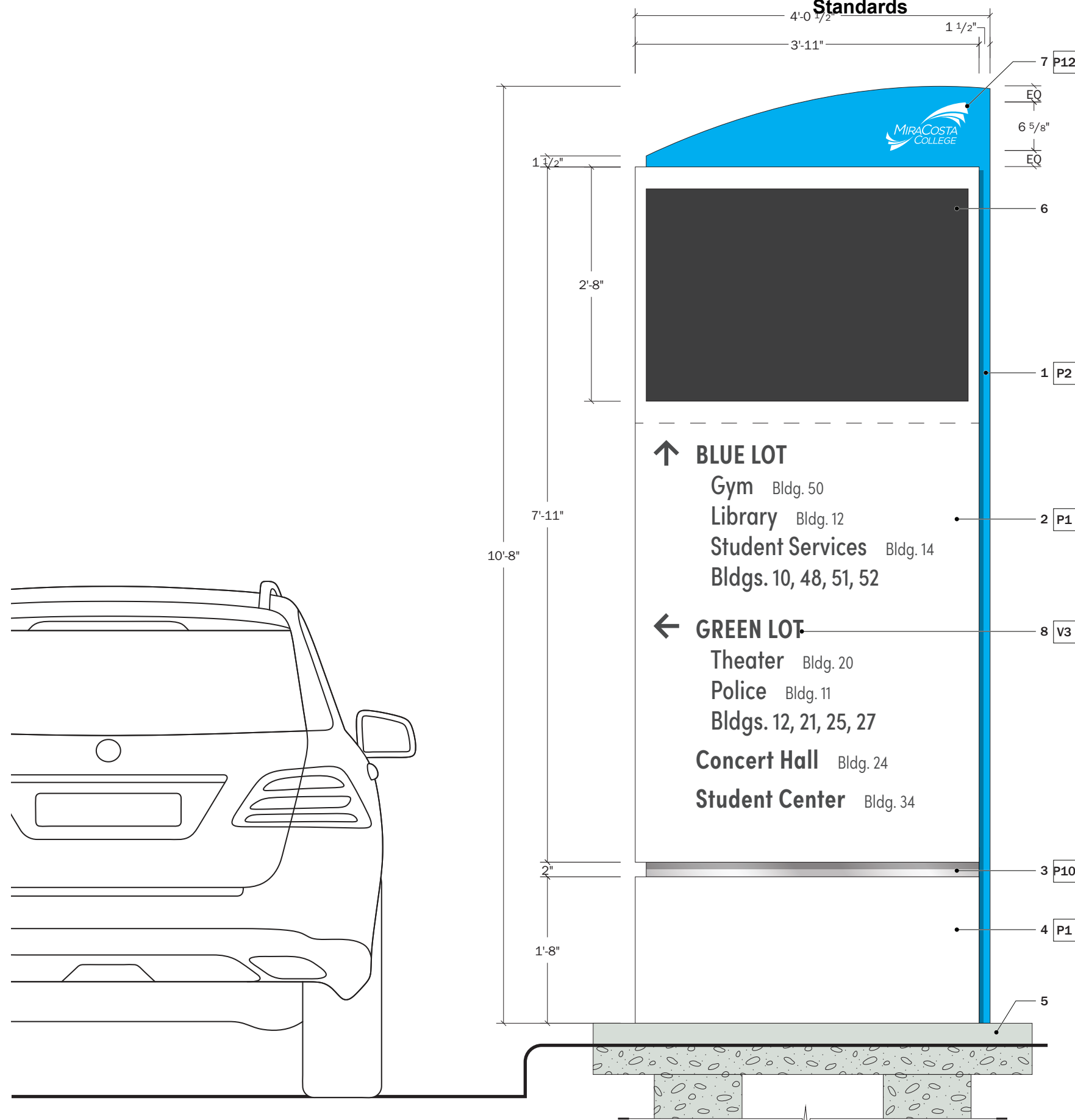
**SIGN TYPE B3
TERTIARY VEHICULAR
DIRECTIONAL**



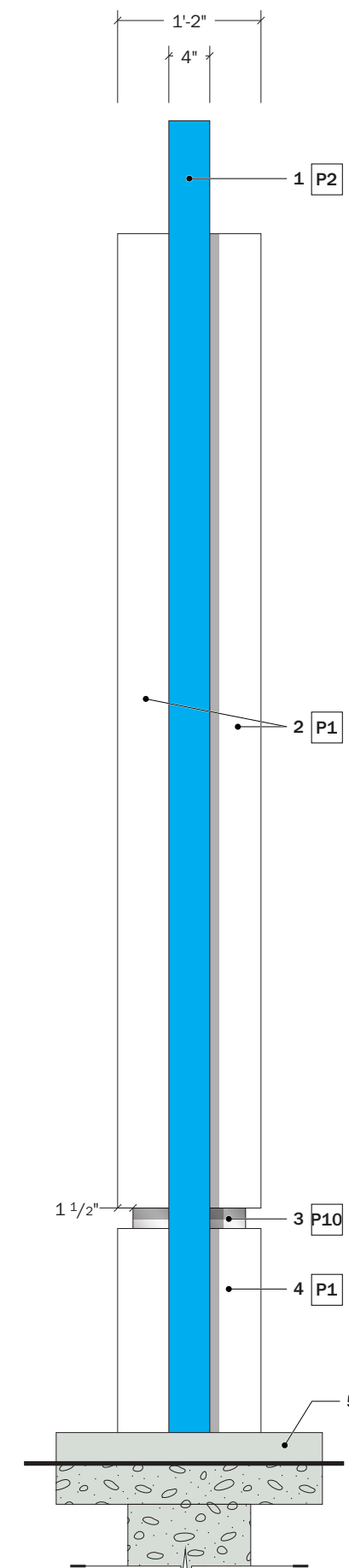
PANEL LAYOUT DIMENSIONS
SCALE: 1 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

MiraCosta College District
Standards



FRONT VIEW
SCALE: 3/4" = 1'-0"



SIDE VIEW

MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS
Oceanside, CA

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DRAWING NOTES

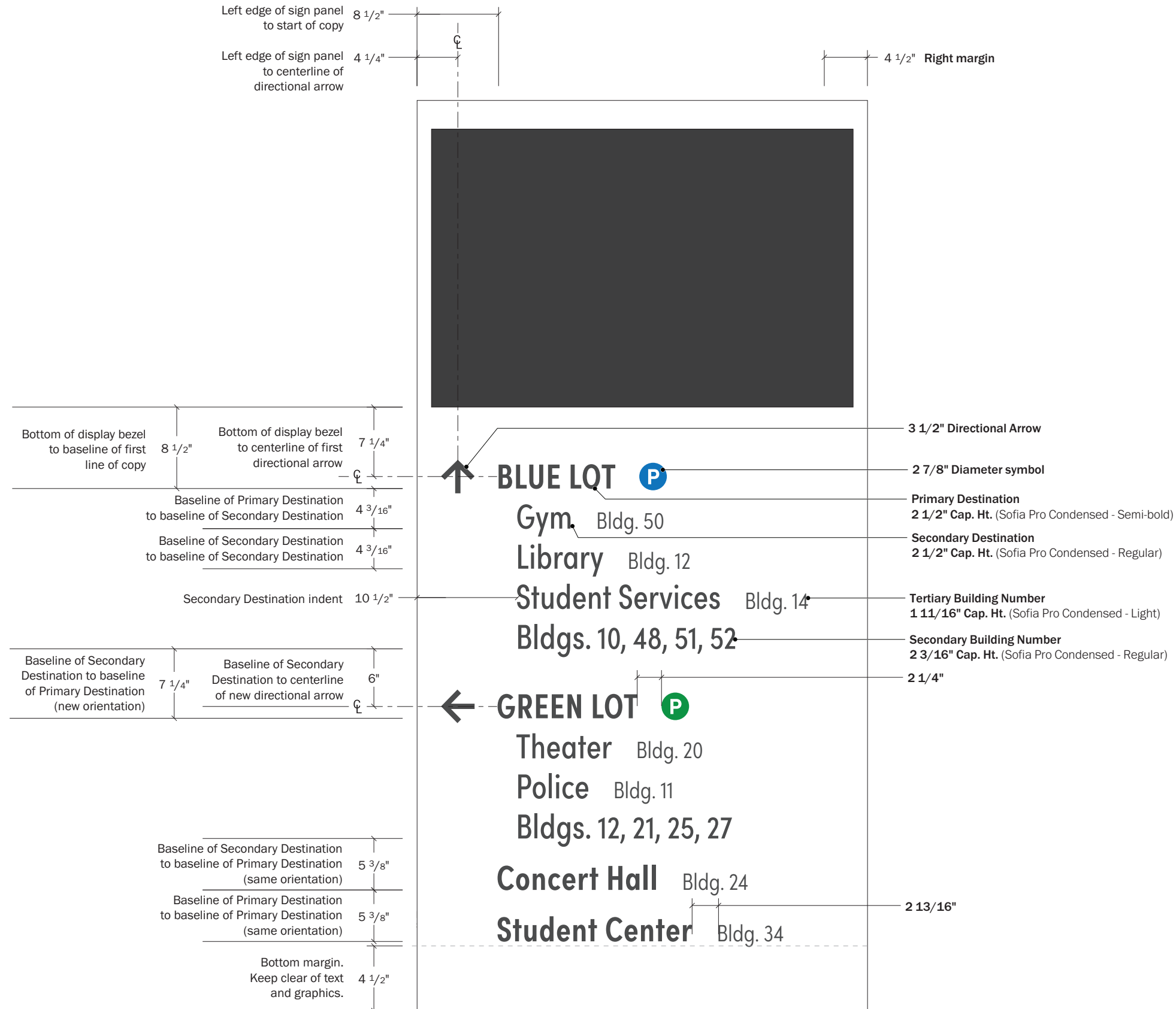
Refer to Sign Type C2 for notes 1-6.

- 8 Applied, premium grade vinyl lettering and symbols as noted. Vinyl is applied free of air bubbles, tears, folds, and creases.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.
- C Sign fabricator to review LED Display specification prior to shop drawings and provide similar unit specifications if unit above is ever discontinued.
- D Sign is intended to be double-sided with LED displays on both sides. Refer to location plans and message schedule to confirm each location is double-sided.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

SIGN TYPE B4
**VEHICULAR DIRECTIONAL W/
LED DISPLAY**

MiraCosta College District
Standards



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MiraCosta College District
Standards

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

Preliminary Signage Standards Manual

DRAWING NOTES

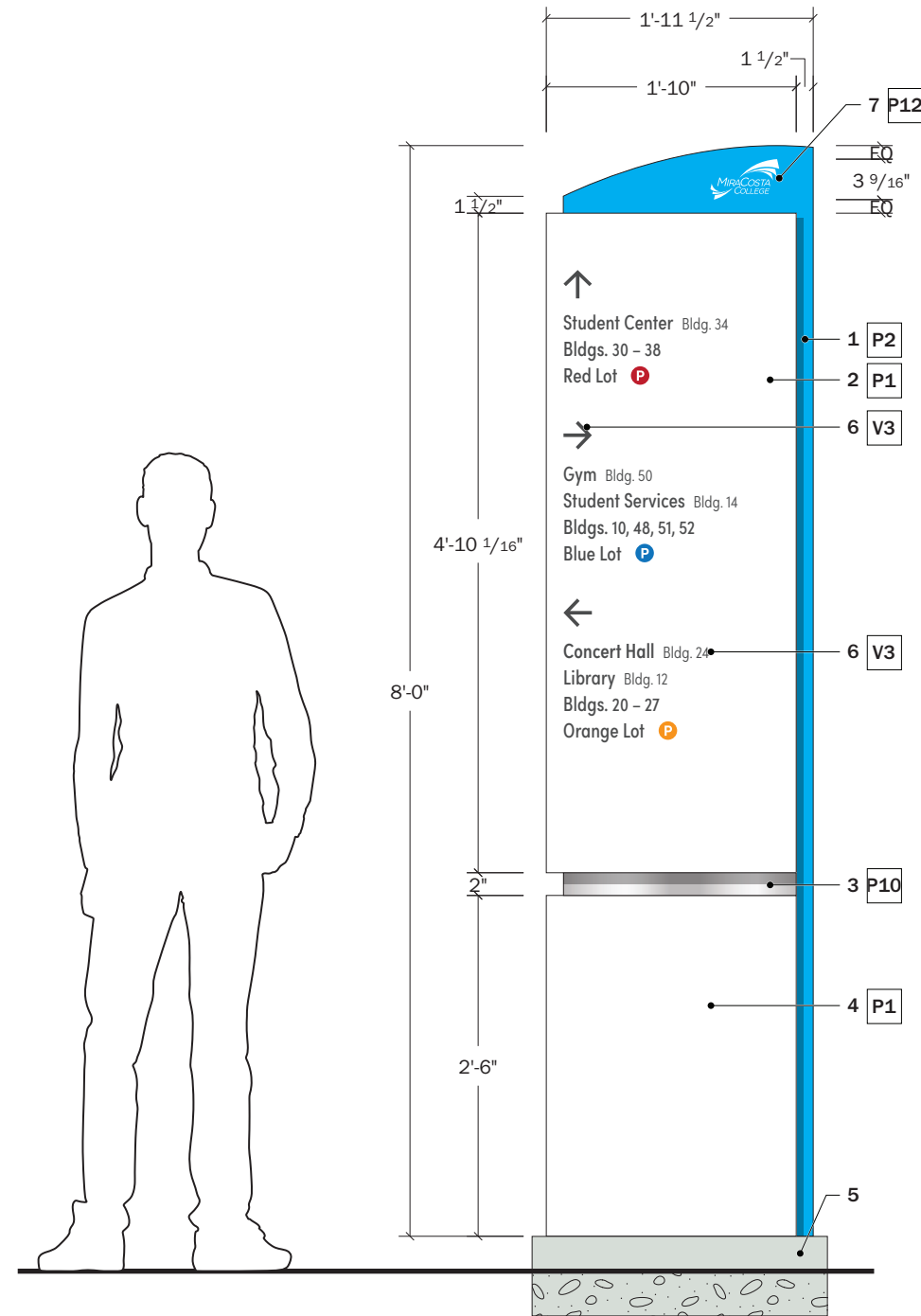
- 1 Fabricated aluminum sign fin w/ internal rigid framing structure and paint finish on all sides. Curvature at top of fin to be the same for all versions of this sign type.
- 2 Fabricated aluminum sign message panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns. Paint fasteners to match sign panel.
- 3 Fabricated reveal w/ paint finish. Reveal to abut to surrounding sign components with no gaps.
- 4 Fabricated aluminum sign footer panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns to provide maintenance access to footing connection. Paint fasteners to match sign panel.
- 5 Concrete footing as required per Sign Fabricator's engineering. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
- 6 Applied, premium grade vinyl lettering and symbols as noted. Vinyl is applied free of air bubbles, tears, folds, and creases.
- 7 Masked and painted logo.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.

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**SIGN TYPE B5
PRIMARY PEDESTRIAN
DIRECTIONAL**

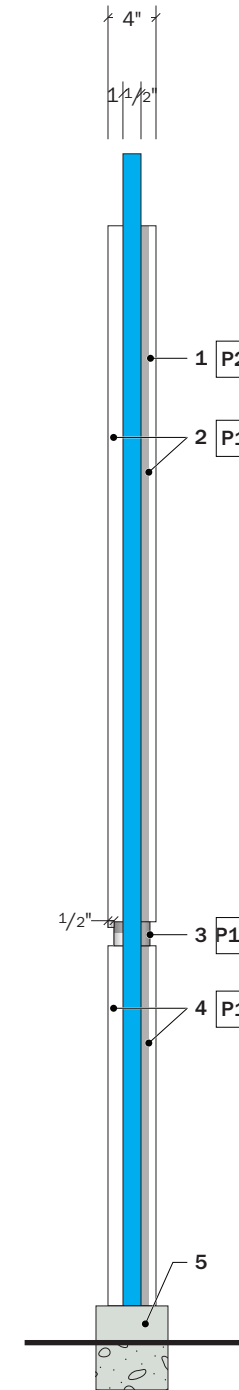


PLAN VIEW

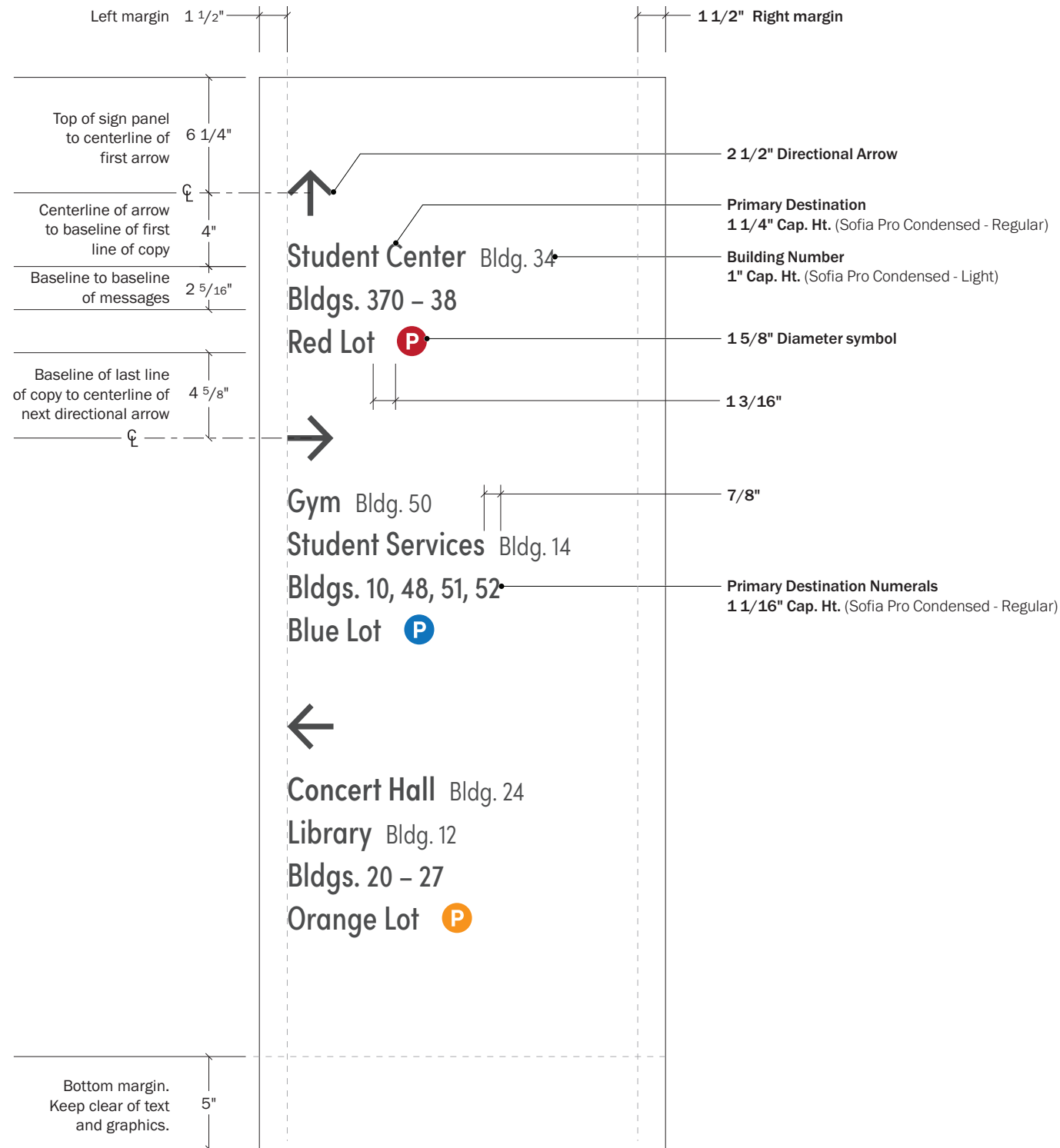


FRONT VIEW

SCALE: 3/4" = 1'- 0"
(sign is double-sided, reference message schedule)



SIDE VIEW



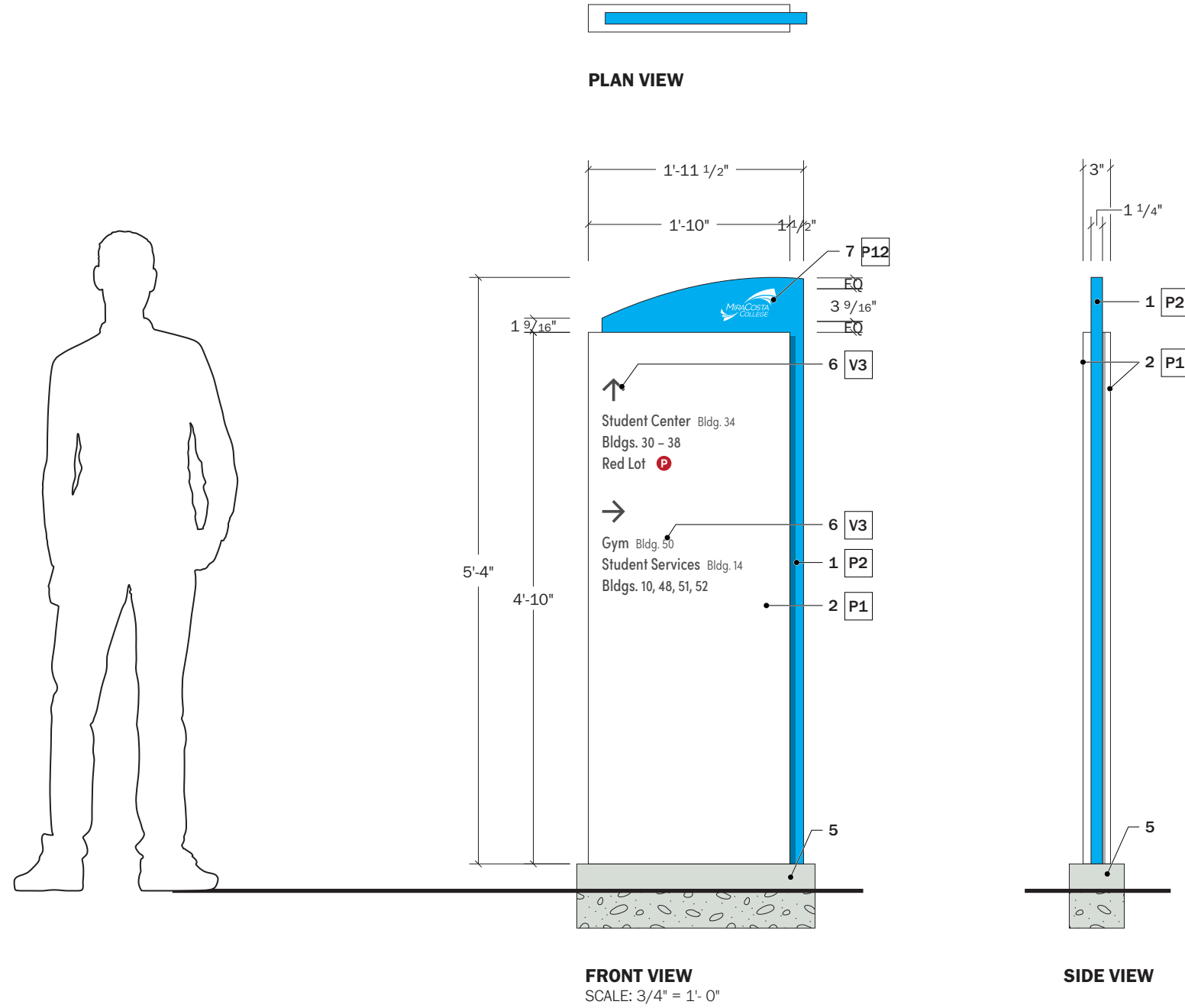
PANEL LAYOUT DIMENSIONS
SCALE: 1 1/2" = 1'- 0"

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**SIGN TYPE B5
MESSAGE LAYOUT**

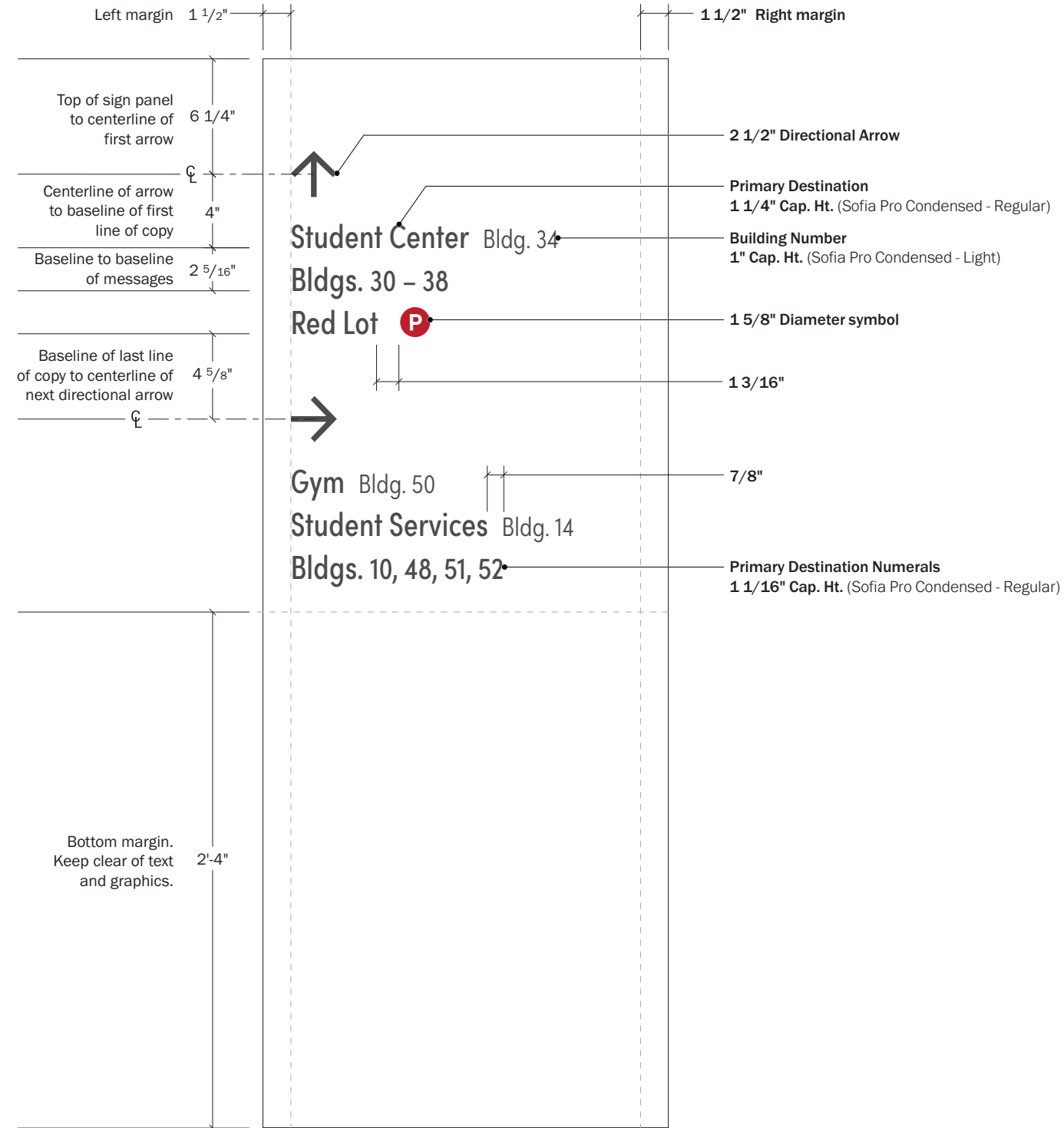
DRAWING NOTES

- 1 Fabricated aluminum sign fin w/ internal rigid framing structure and paint finish on all sides. Curvature at top of fin to be the same for all versions of this sign type.
- 2 Fabricated aluminum sign message panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns to provide maintenance access to footer connection. Paint fasteners to match sign panel.
- 3 Concrete footing as required per Sign Fabricator's engineering. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
- 4 Applied, premium grade vinyl lettering and symbols as noted. Vinyl is applied free of air bubbles, tears, folds, and creases.
- 5 Masked and painted logo.
- 6 Applied, premium grade vinyl lettering and symbols as noted. Vinyl is applied free of air bubbles, tears, folds, and creases.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.



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**SIGN TYPE B6
SECONDARY PEDESTRIAN
DIRECTIONAL**



PANEL LAYOUT DIMENSIONS
SCALE: 1 1/2" = 1'- 0"

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**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**

Oceanside, CA

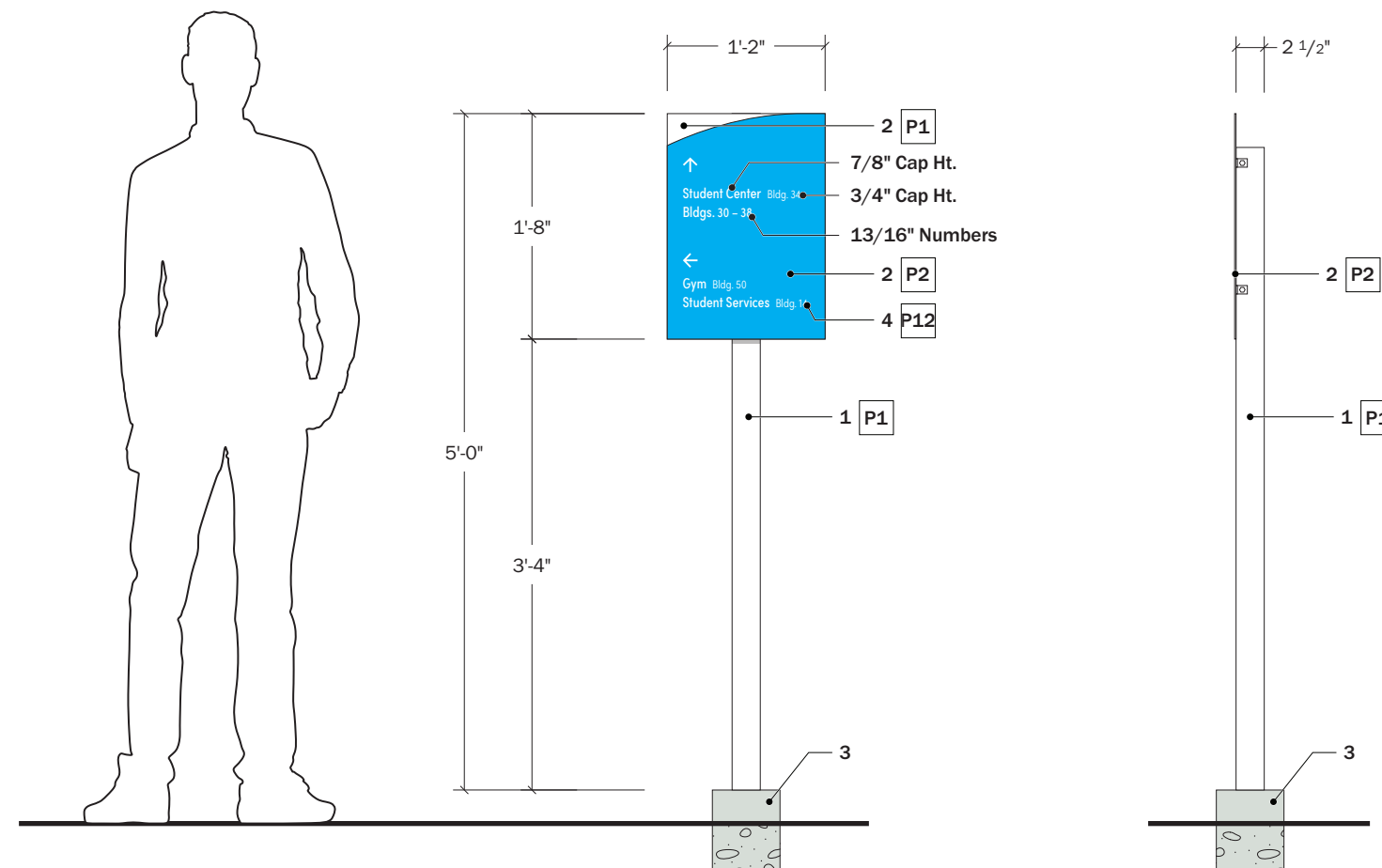
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Preliminary Signage Standards Manual

DRAWING NOTES

- 1 2 1/2" square aluminum post w/ paint finish on all sides. Post is capped at top. Post is secured into concrete footing.
 - 2 1/8" thick aluminum sign panel w/ masked and painted graphic. Backside is painted as noted. Sign panel is secured to post with mechanical fasteners via painted angles welded to back of panel. Angles are painted to match sign and post. Welds to be ground smooth and made neat.
 - 3 Concrete footing with depth below grade as required to maintain stability. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
 - 4 Applied, premium grade vinyl lettering and symbols as noted. Vinyl is applied free of air bubbles, tears, folds, and creases.
- A Sign to be mounted plumb and level.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.

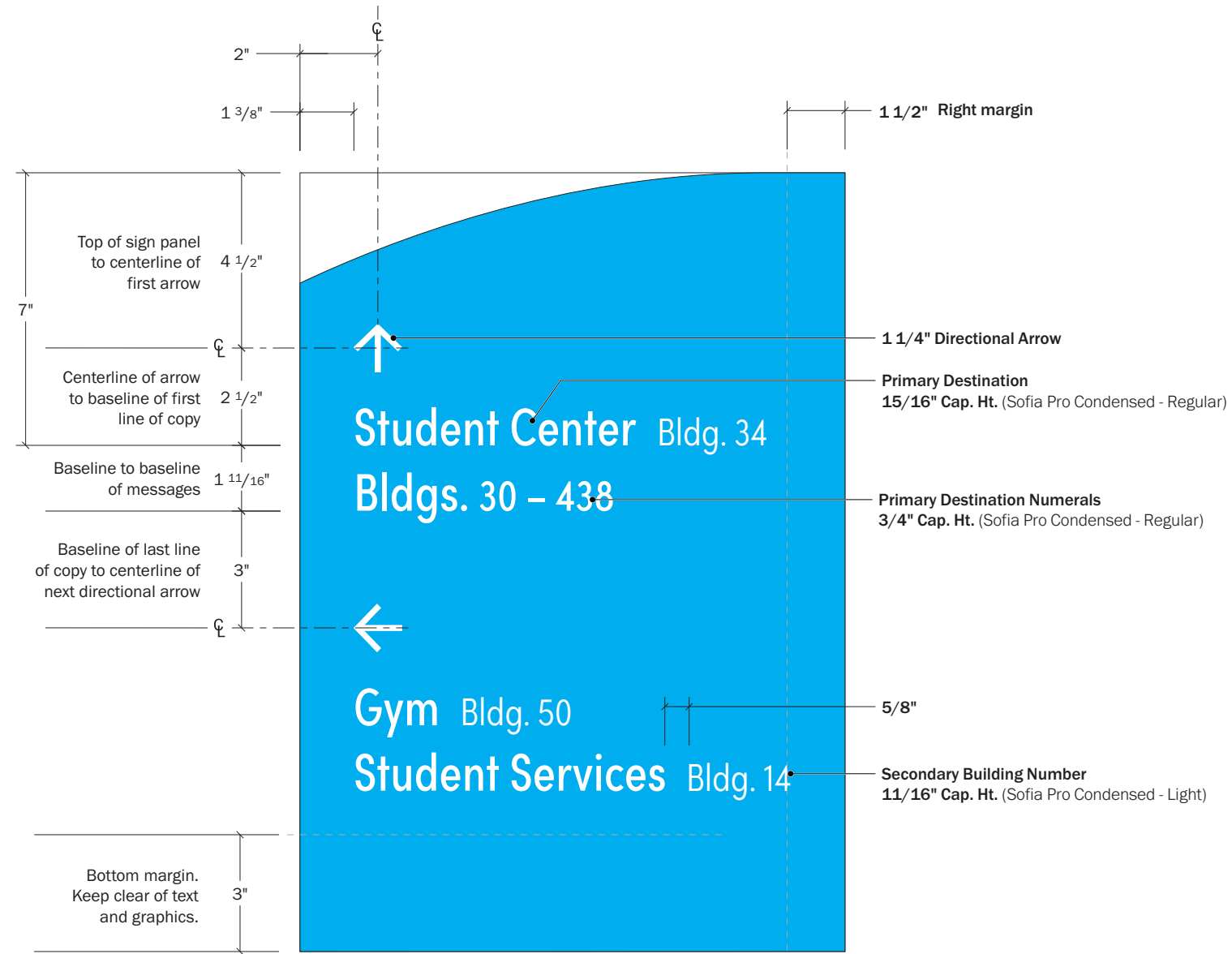


FRONT VIEW
SCALE: 3/4" = 1'-0"

SIDE VIEW

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE B7
TERTIARY PEDESTRIAN
DIRECTIONAL**

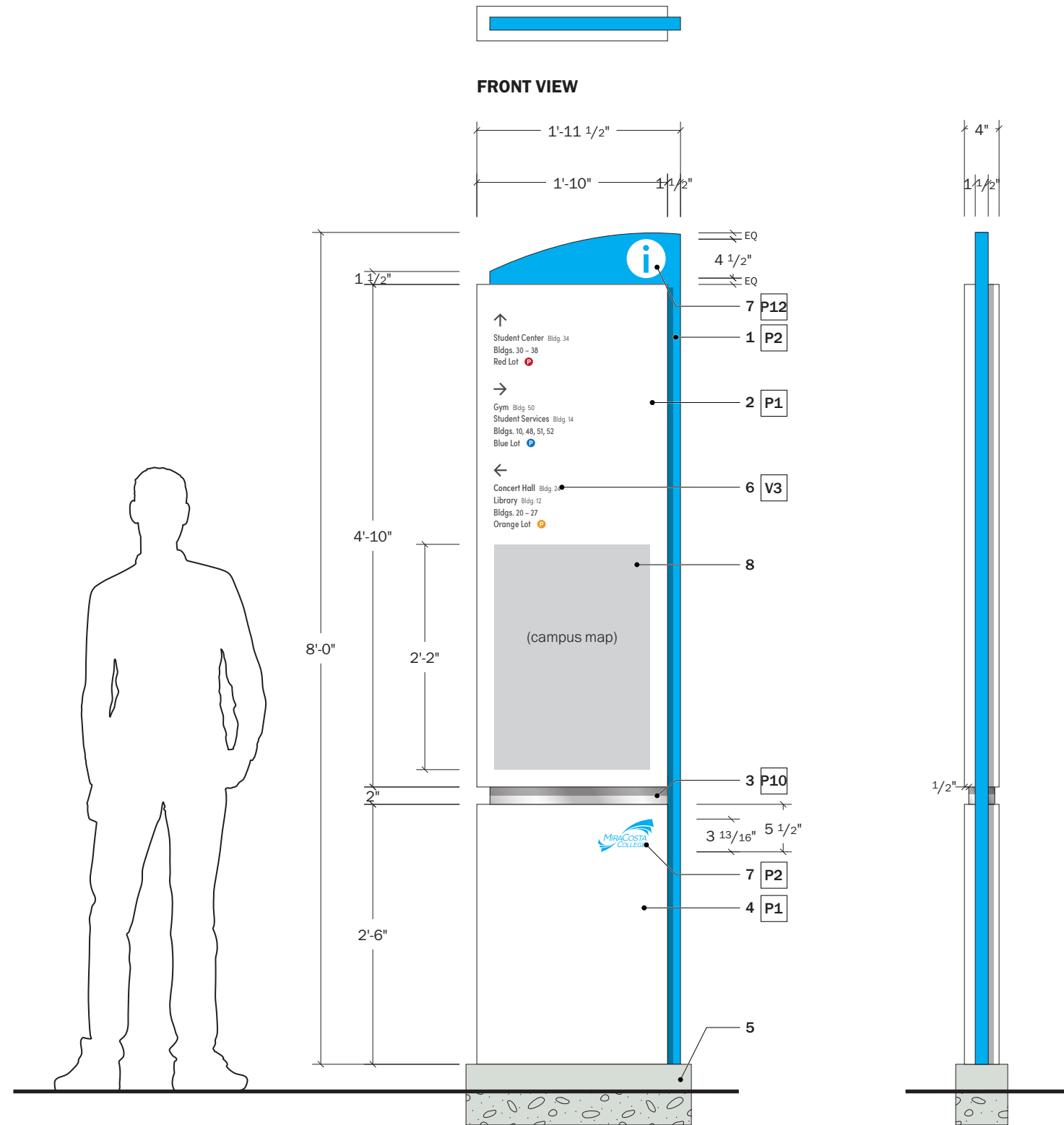


PANEL LAYOUT DIMENSIONS
SCALE: 3" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

DRAWING NOTES

- 1 Fabricated aluminum sign fin w/ internal rigid framing structure and paint finish on all sides. Curvature at top of fin to be the same for all versions of this sign type.
 - 2 Fabricated aluminum sign message panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns. Paint fasteners to match sign panel.
 - 3 Fabricated reveal w/ paint finish. Reveal to abut to surrounding sign components with no gaps.
 - 4 Fabricated aluminum sign footer panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns to provide maintenance access to footing connection. Paint fasteners to match sign panel.
 - 5 Concrete footing as required per Sign Fabricator's engineering. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
 - 6 Applied, premium grade vinyl lettering and symbols as noted. Vinyl is applied free of air bubbles, tears, folds, and creases.
 - 7 Masked and painted logo/symbol.
 - 8 HD printed vinyl campus map. Map art to be provided by college for initial installation/application. Map to be applied free of air-bubbles, folds, creases or tears.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.

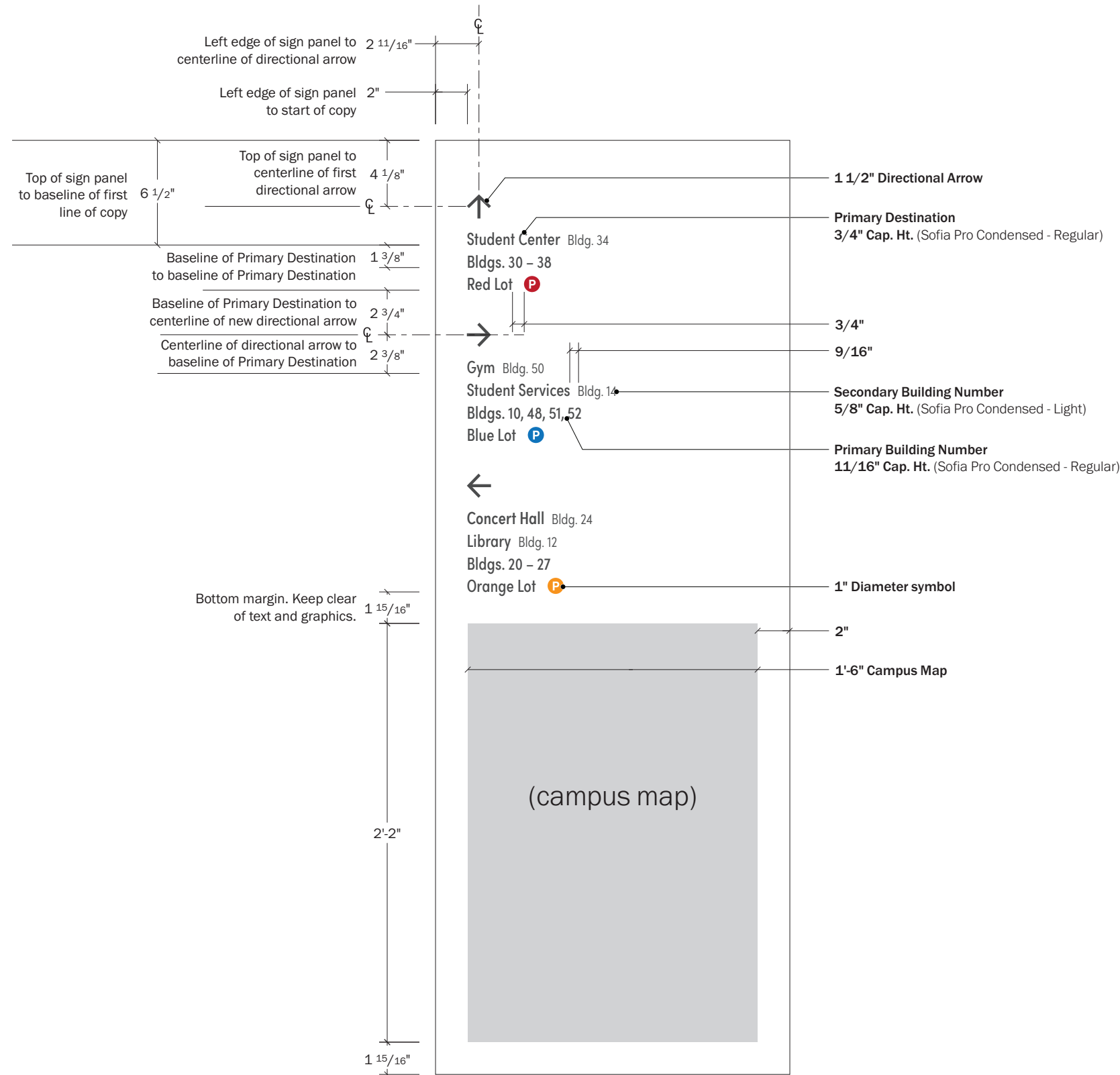


FRONT VIEW
SCALE: 3/4" = 1'- 0"
(Sign is double-sided - reference message schedule)

SIDE VIEW

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE B8
PEDESTRIAN DIRECTIONAL W/
CAMPUS MAP**



PANEL LAYOUT DIMENSIONS
SCALE: $1 \frac{1}{2}$ " = 1'-0"

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MiraCosta College District Standards

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

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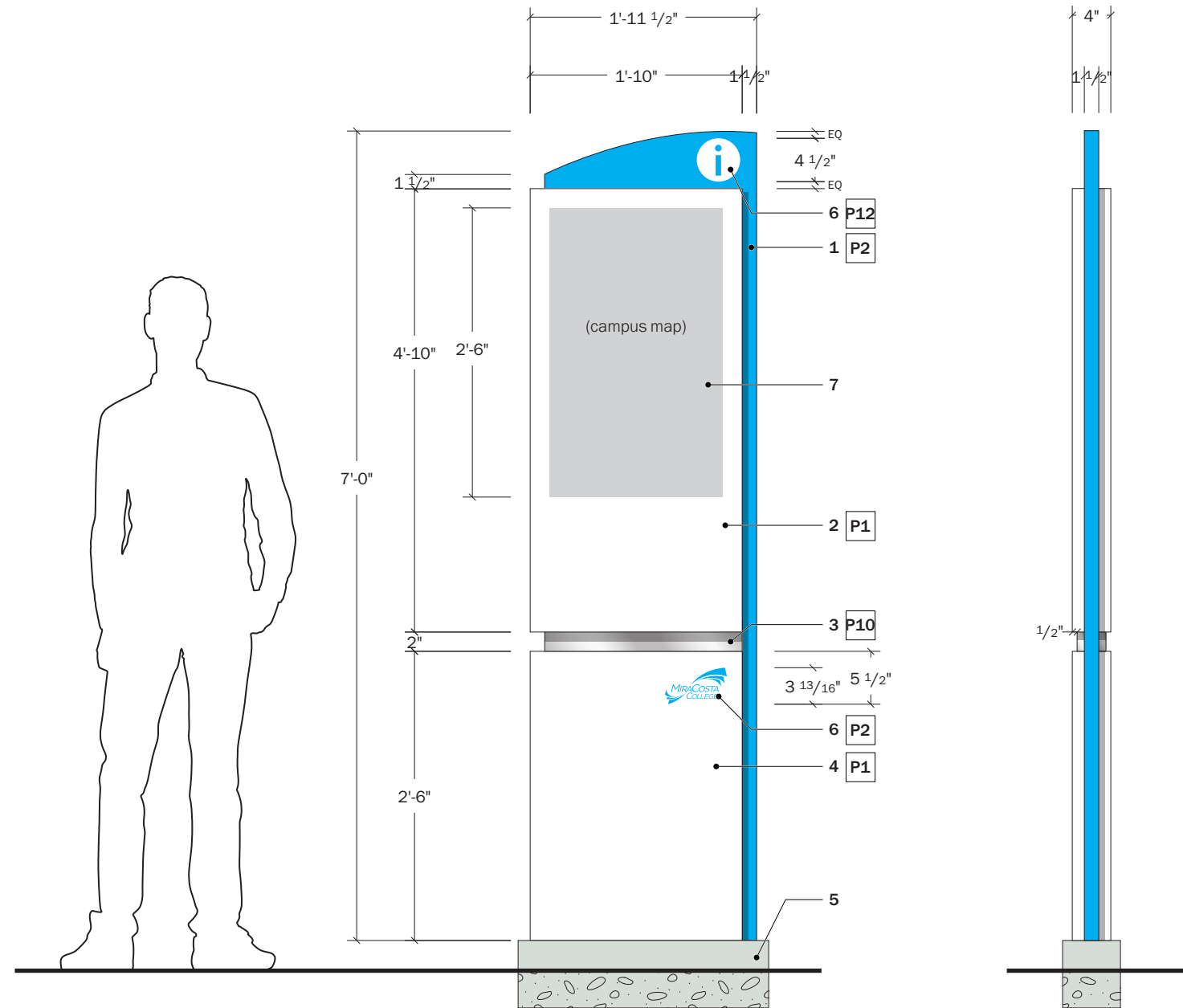
DRAWING NOTES

- 1 Fabricated aluminum sign fin w/ internal rigid framing structure and paint finish on all sides. Curvature at top of fin to be the same for all versions of this sign type.
- 2 Fabricated aluminum sign message panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns. Paint fasteners to match sign panel.
- 3 Fabricated reveal w/ paint finish. Reveal to abut to surrounding sign components with no gaps.
- 4 Fabricated aluminum sign footer panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns to provide maintenance access to footing connection. Paint fasteners to match sign panel.
- 5 Concrete footing as required per Sign Fabricator's engineering. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
- 6 Masked and painted logo/symbol.
- 7 HD printed vinyl campus map. Map art to be provided by college for initial installation/application. Map to be applied free of air-bubbles, folds, creases or tears.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.



PLAN VIEW



FRONT VIEW

SCALE: 3/4" = 1'- 0"
(Sign is double-sided - reference message schedule)

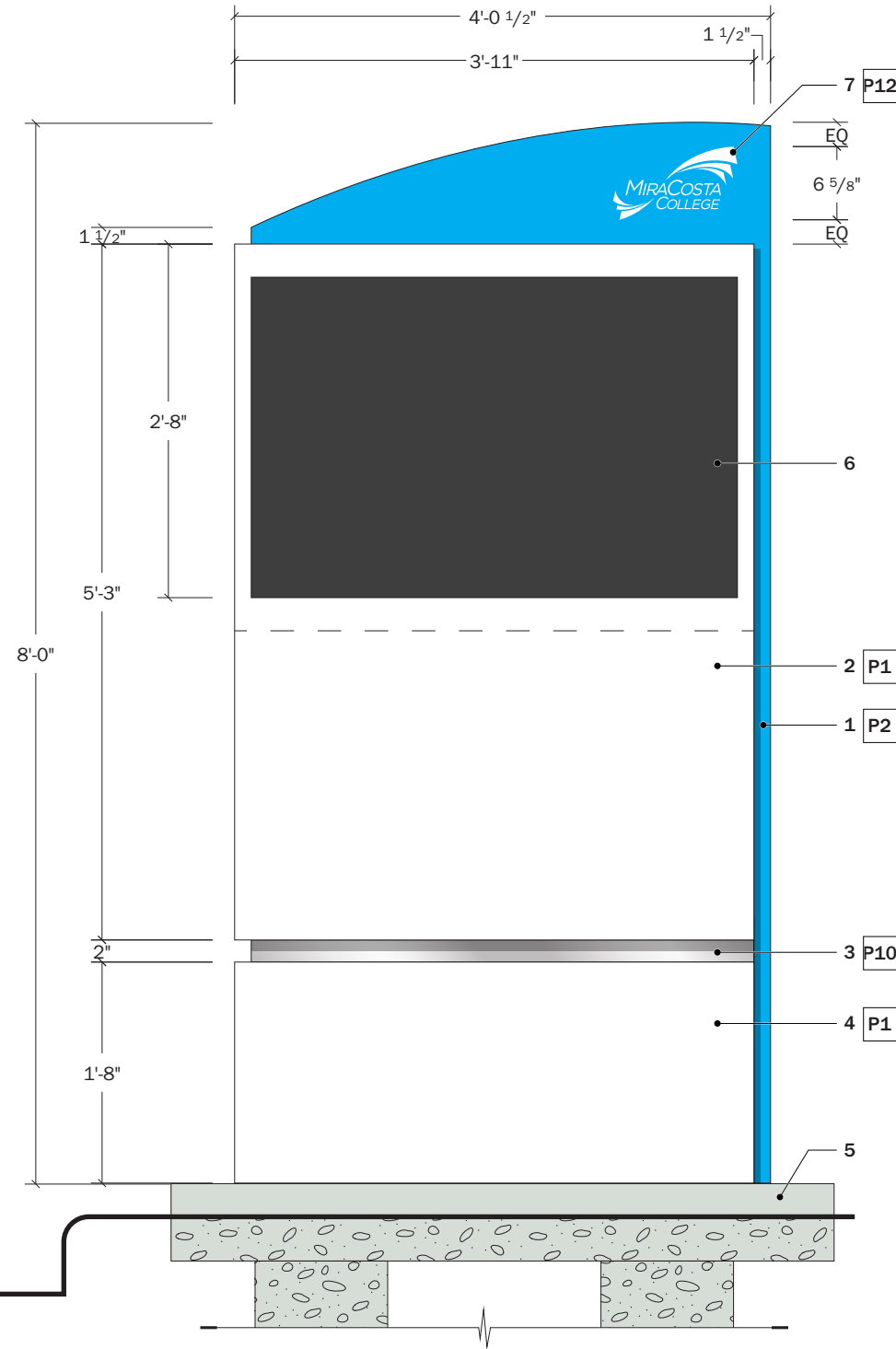
SIDE VIEW

**SIGN TYPE C1
CAMPUS DIRECTORY MAP**

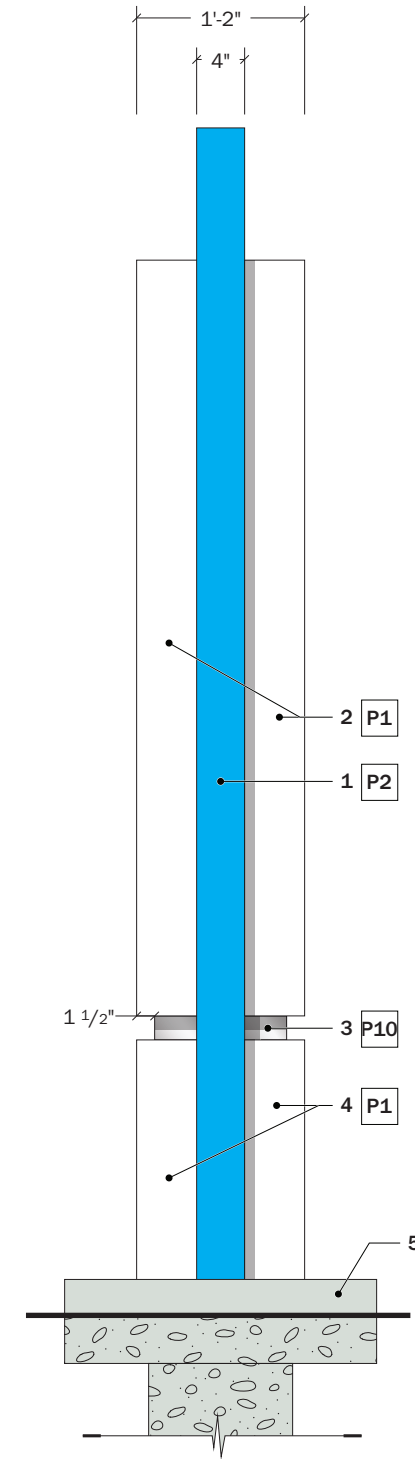
MiraCosta College District
Standards



PLAN VIEW



FRONT VIEW
SCALE: 3/4" = 1'-0"
(double-sided)



SIDE VIEW

MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS

Oceanside, CA

75-22602-00

July 18, 2023

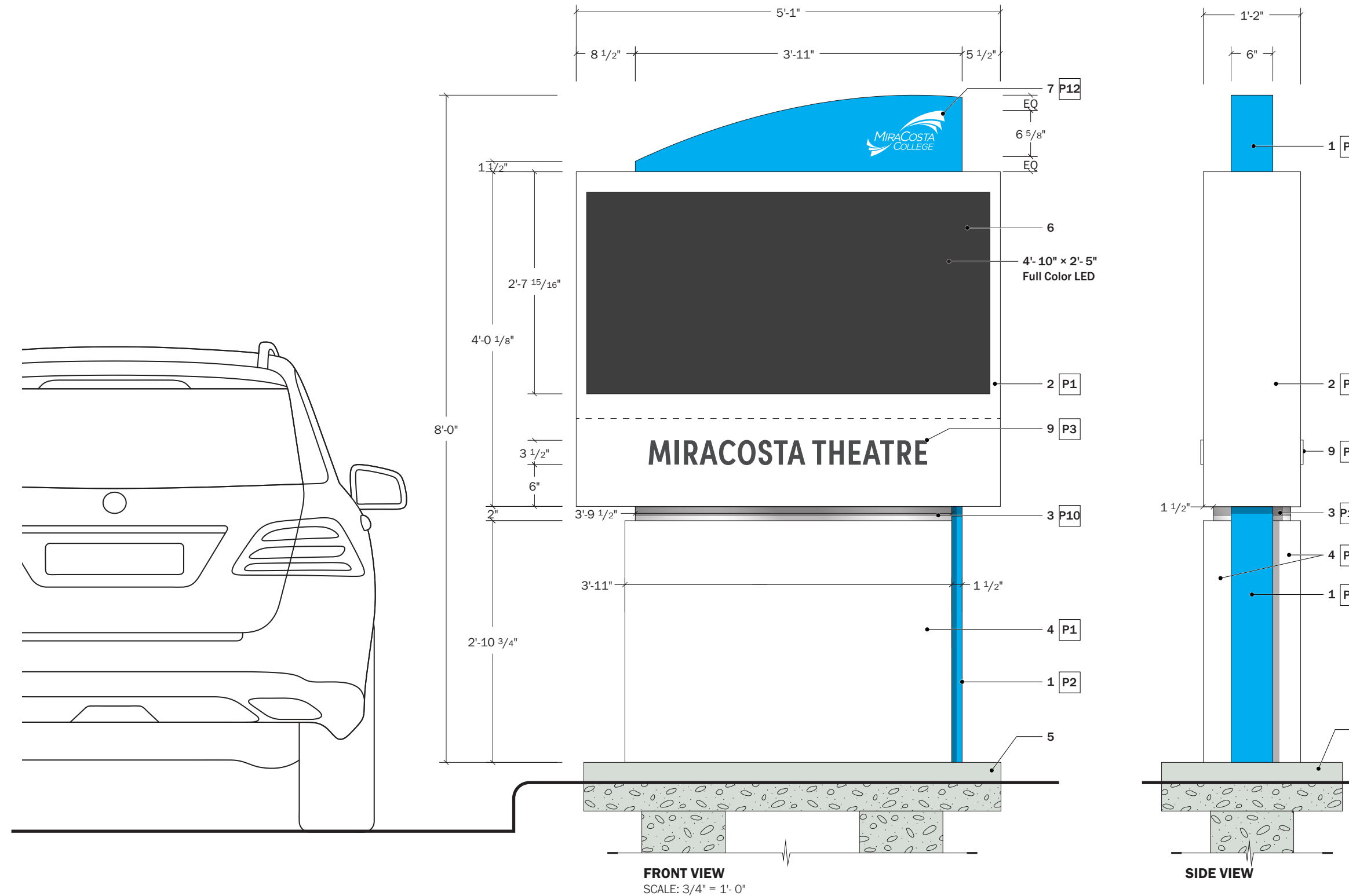
Preliminary Signage Standards Manual

DRAWING NOTES

- 1 Fabricated aluminum sign fin w/ internal rigid framing structure and paint finish on all sides. Curvature at top of fin to be the same for all versions of this sign type.
 - 2 Fabricated aluminum sign cabinet w/ internal rigid framing structure and paint finish on all sides. Cabinet to support LED message board. Faces of sign cabinet to be removable for maintenance access via tamper-proof, flathead mechanical fasteners on sign returns. Paint fasteners to match sign panel.
 - 3 Fabricated reveal w/ paint finish. Reveal to abut to surrounding sign components with no gaps.
 - 4 Fabricated aluminum sign footer panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel are removable via tamper-proof, flathead mechanical fasteners on sign returns to provide maintenance access to footing connection. Paint fasteners to match sign panel.
 - 5 Concrete footing as required per Sign Fabricator's engineering. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
 - 6 Daktronics GT6x-90-135-8-RGB-DF. LED unit is housed within sign cabinet. All electrical connections and components to be concealed within sign. Sign fabricator to coordinate with College data connection type for each location prior to fabrication and shop drawings. Display is double-sided
 - 7 Masked and painted logo.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.
- C Sign fabricator to review LED Display specification prior to shop drawings and provide similar unit specifications if unit above is ever discontinued.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

SIGN TYPE C2
FREESTANDING DIGITAL
DISPLAY



DRAWING NOTES

Refer to notes on previous sheet.

- 6 Daktronics GT6-90-x180-8-RGB-DF Display or comparable. LED unit is housed within sign cabinet. All electrical connections and components to be concealed within sign. Sign fabricator to coordinate with College data connection type for each location prior to fabrication and shop drawings. Display is double-sided.
- 9 Push-thru, clear acrylic lettering w/ halo-glow illumination from warm white LEDs. Letter faces are made opaque to block light. Power supply and any required electrical components to be concealed internally within sign cabinet.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.
- C Sign fabricator to review LED Display specification prior to shop drawings and provide similar unit specifications if unit above is ever discontinued.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE C3
THEATRE BUILDING DIGITAL
MARQUEE**

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**

Oceanside, CA

75-22602-00

July 18, 2023

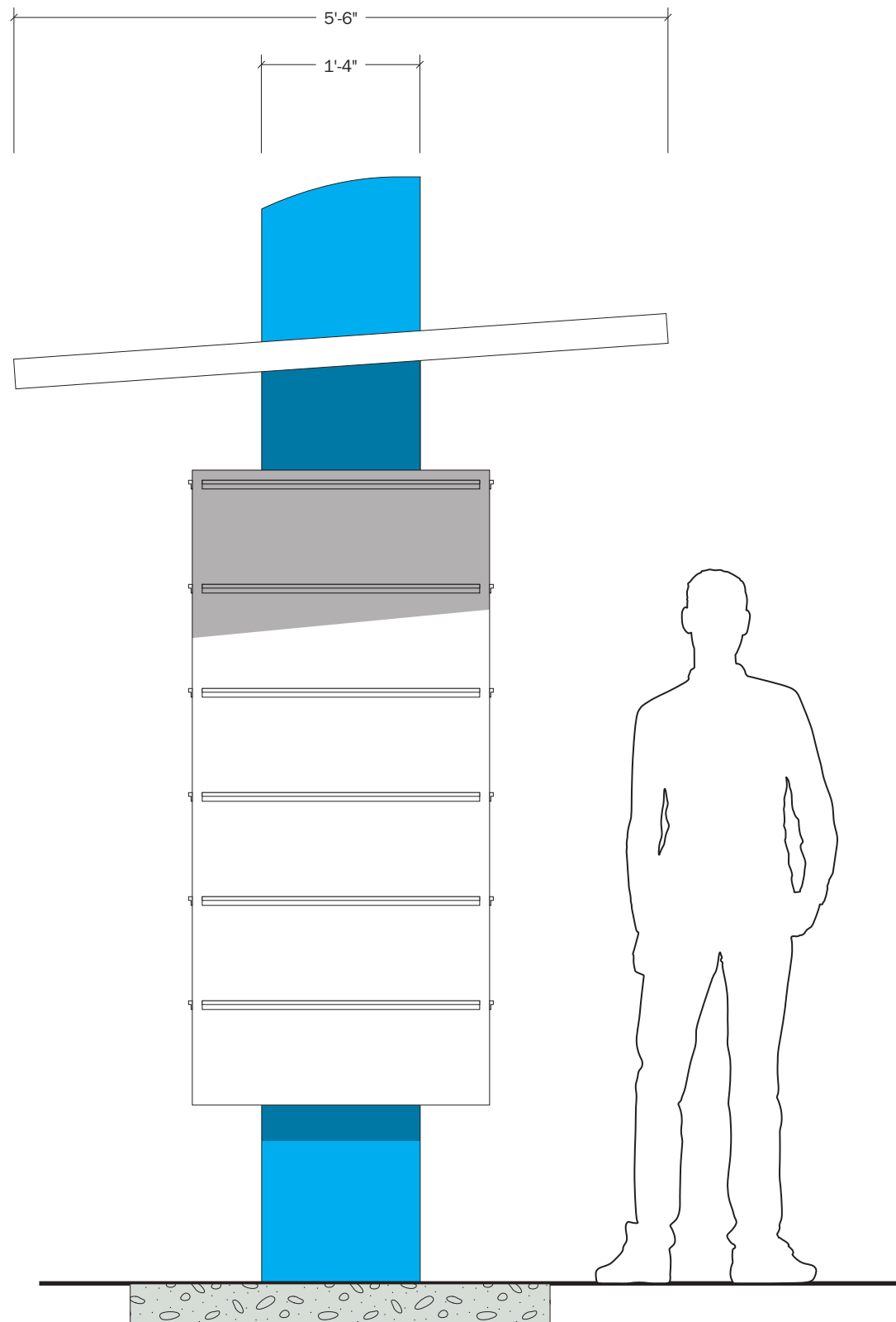
Preliminary Signage Standards Manual

DRAWING NOTES

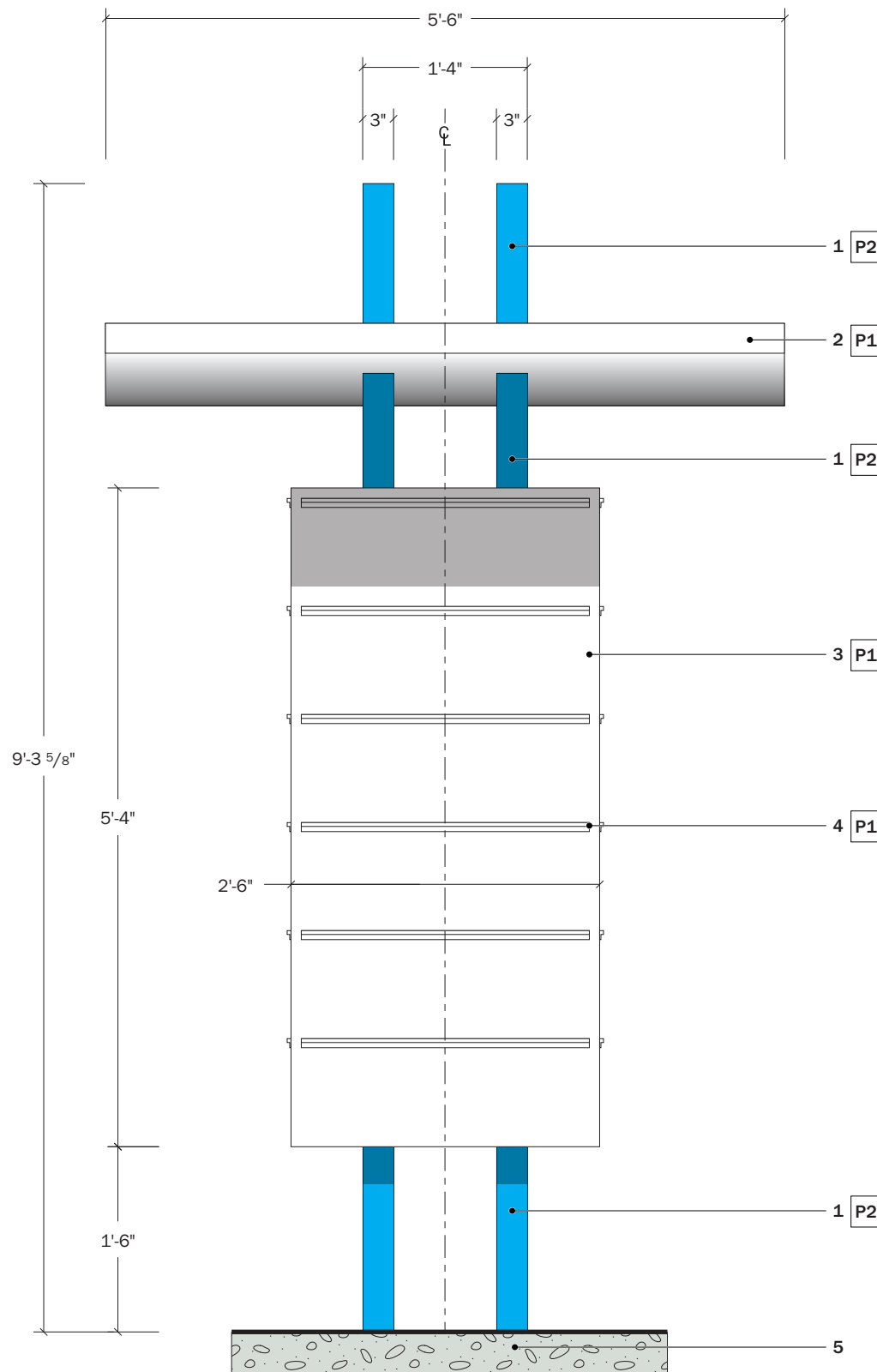
- 1 Steel support posts with paint finish on all sides. Posts have custom cut curve at top. Ends are capped. Sign fabricator to develop mechanical fastener connection to below grade footing which would allow for future removal if necessary.
 - 2 Fabricated metal roof structure. Roof is secured to support posts as required. Include bracing and support as required by engineering. Roof has slight tilt to assist with water runoff. Roof to be corrugated metal with paint finish and enclosed flat underside. Sign fabricator to develop with input from engineering. Connections to support posts and any penetrations to be made water-proofed.
 - 3 Metal posting panel w/ paint finish on all sides and reinforced w/ concealed metal supports to prevent warping and oil-canning effect. Panels are secured to structure with flat-head mechanical fasteners as required to prevent detachment. Panels are meant to be easily changed out for cleaning or repairs if needed. Panels to align perfectly with each other at edges (panels included on 4 sides)
 - 4 Aluminum clipping system with ball-bearing, friction hold. Ends of clips are enclosed to prevent bearings from falling out. Clips are secured to posting panel with flat-head counter-sunk mechanical fasteners. Paint clips to match posting panel.
 - 5 Below-grade, concrete footing as required per Sign Fabricator's engineering. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure, roof, and connection of roof to supports considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.
- C Confirm each location prior to shop drawings to determine appropriate footing necessary.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE C4
INFORMATION BULLETIN
KIOSK**



SIDE VIEW



FRONT VIEW

SCALE: 3/4" = 1'-0"

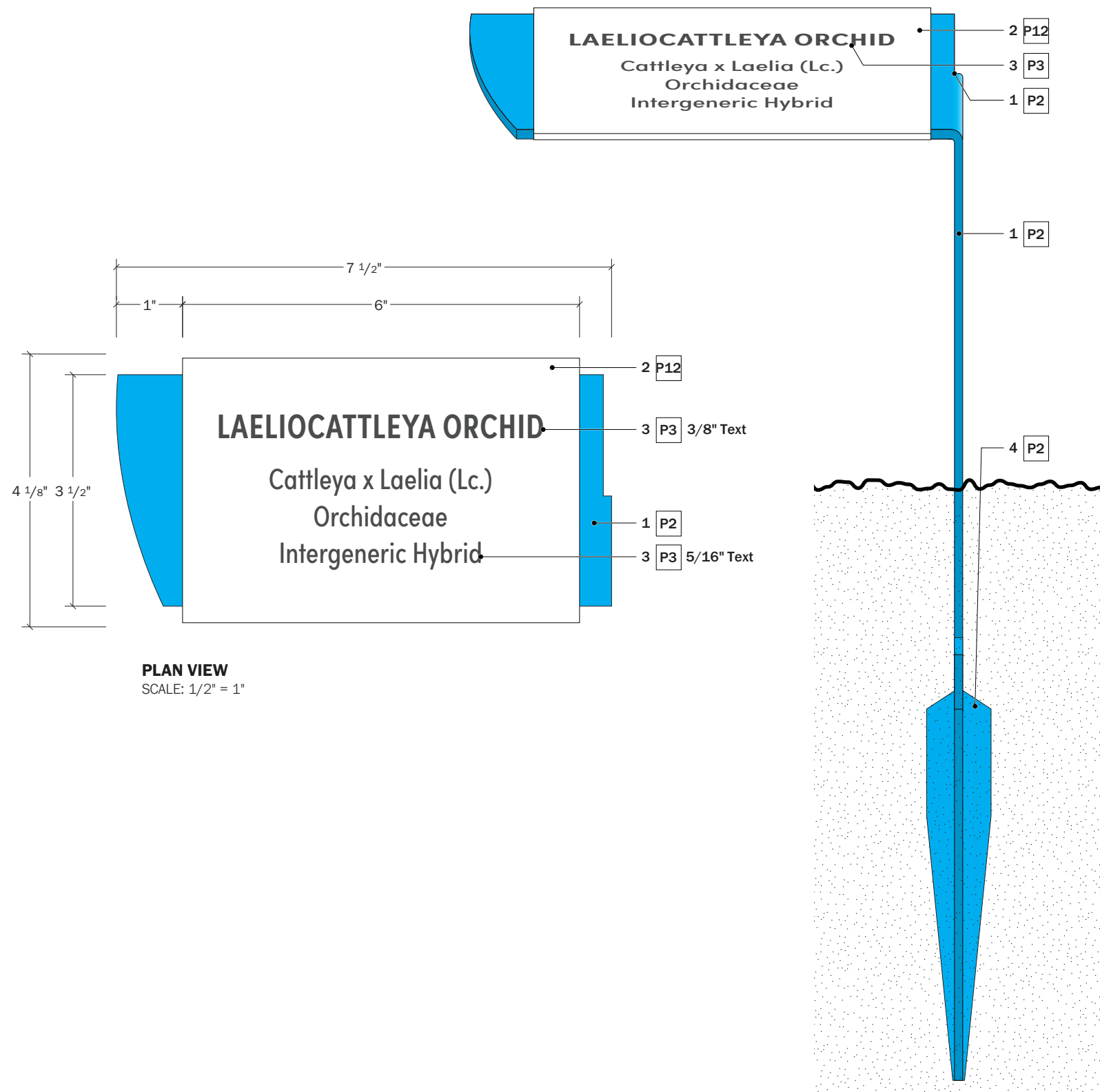
**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

Preliminary Signage Standards Manual

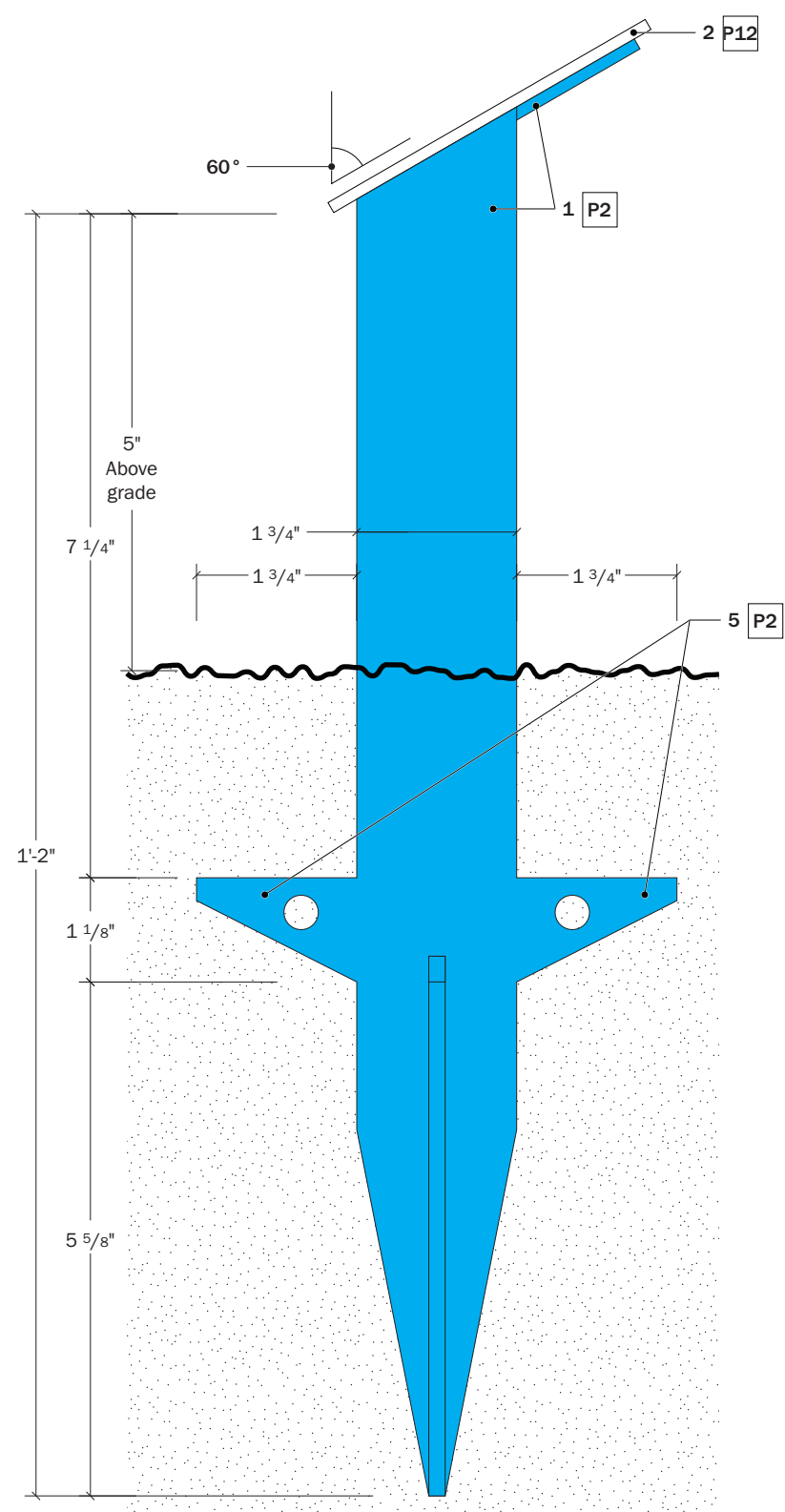
DRAWING NOTES

- 1 Formed, 1/8" thick, steel stake with paint finish on all sides. Stake has bend and cut to create a mounting surface for sign message panel. Stake has fins and anchor points to assist in preventing sign from twisting or becoming dislodged. Stake to be buried in ground as shown.
 - 2 1/8 thick acrylic message panel with paint finish on all sides. Panel has silk-screened copy on first surface. panel is adhered to stake with full coverage adhesive.
 - 3 Silk-screened message on sign panel. Owner to provide copy for each sign as needed.
 - 4 Welded, steel support fins. Fins are included on each opposite side of cut-out steel stake. Fins are tapered to a non-sharp point.
 - 5 Cut-out support fins included as part of stake.
- A Quantities and messages to be determined by Owner.
- B Fabricator to field test prototype prior to full scale fabrication to ensure sign is sturdy and will not tip over. Fabricator to make modifications to below grade parts of sign as needed to ensure sign is stable.



PLAN VIEW
SCALE: 1/2" = 1"

FRONT VIEW
SCALE: 1/2" = 1"



SIDE VIEW

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE C5
PLANT INFORMATION PLAQUE**

MiraCosta College District
Standards

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

Preliminary Signage Standards Manual

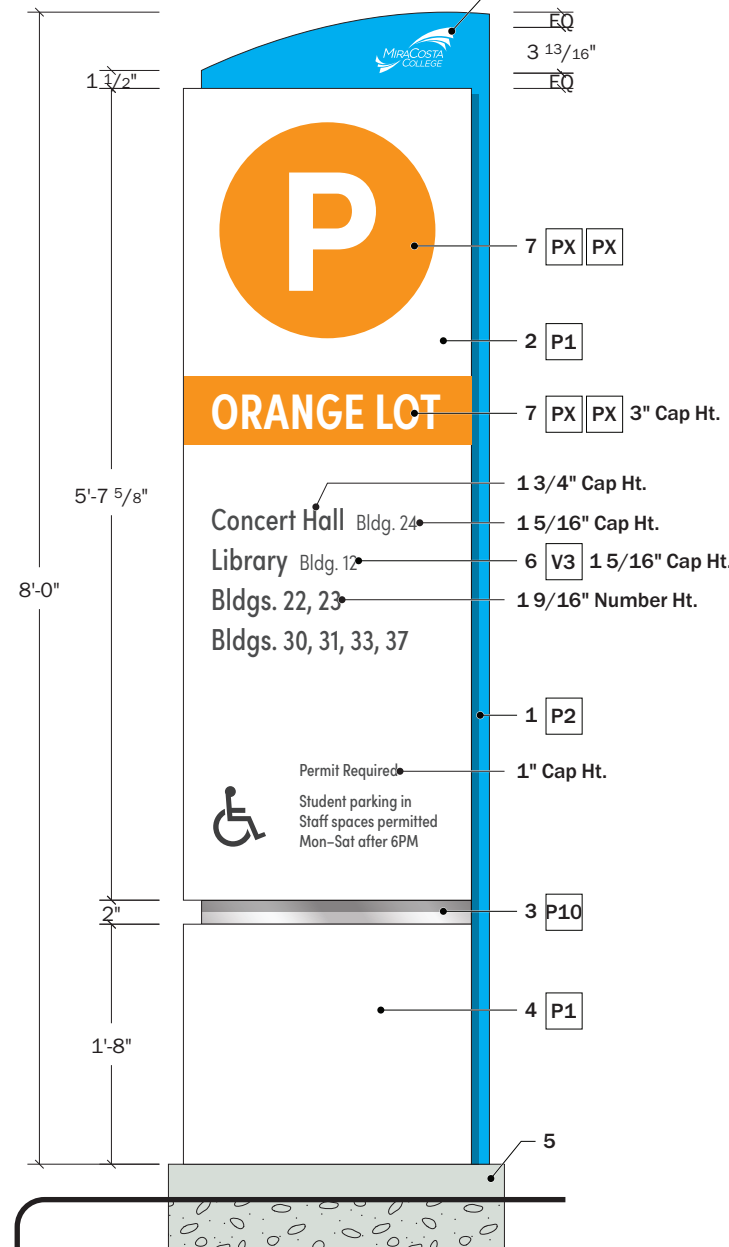
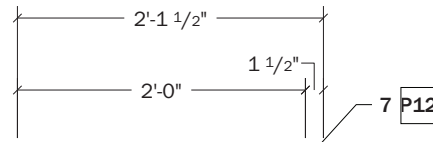
DRAWING NOTES

- 1 Fabricated aluminum sign fin w/ internal rigid framing structure and paint finish on all sides. Curvature at top of fin to be the same for all versions of this sign type.
 - 2 Fabricated aluminum sign message panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns. Paint fasteners to match sign panel.
 - 3 Fabricated reveal w/ paint finish. Reveal to abut to surrounding sign components with no gaps.
 - 4 Fabricated aluminum sign footer panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns to provide maintenance access to footing connection. Paint fasteners to match sign panel.
 - 5 Concrete footing as required per Sign Fabricator's engineering. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
 - 6 Applied, premium grade vinyl lettering and symbols as noted. Vinyl is applied free of air bubbles, tears, folds, and creases.
 - 7 Masked and painted logo, graphics and text.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.

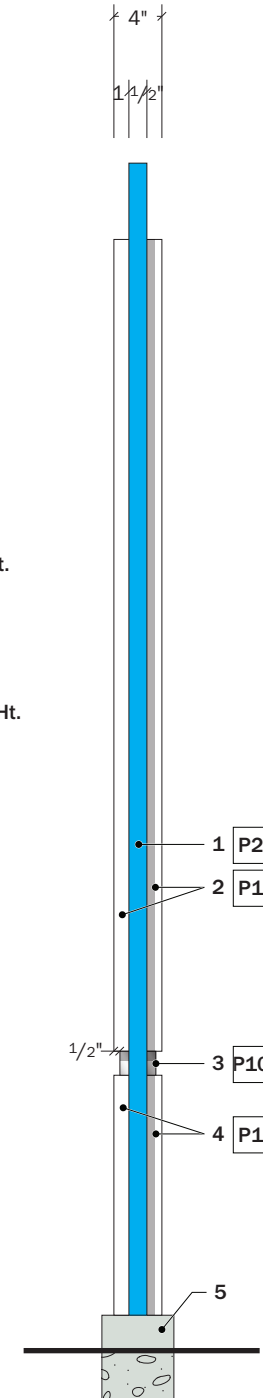
All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE P1
PRIMARY PARKING LOT
IDENTIFICATION**

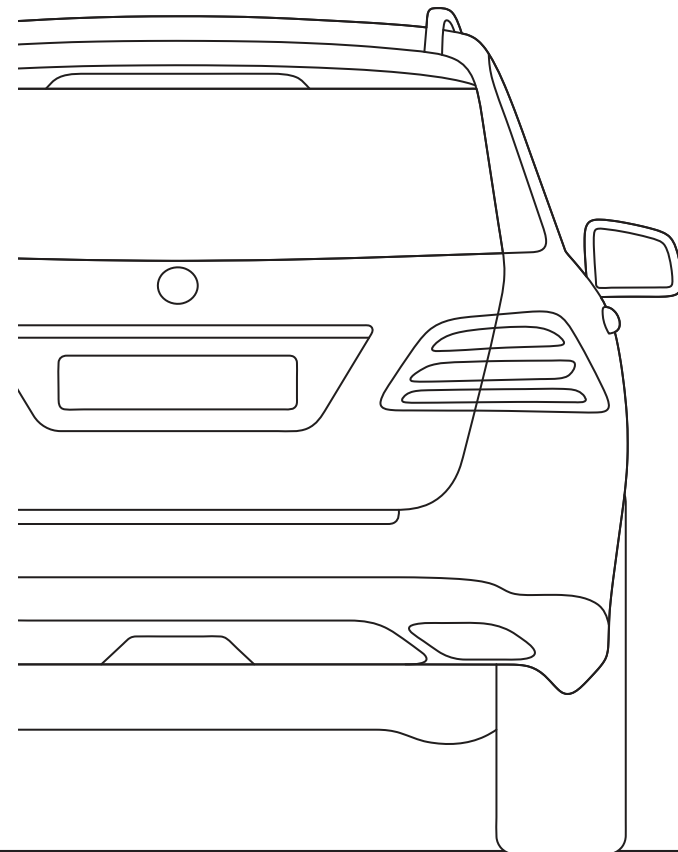
PLAN VIEW



FRONT VIEW
SCALE: 3/4" = 1'- 0"



SIDE VIEW

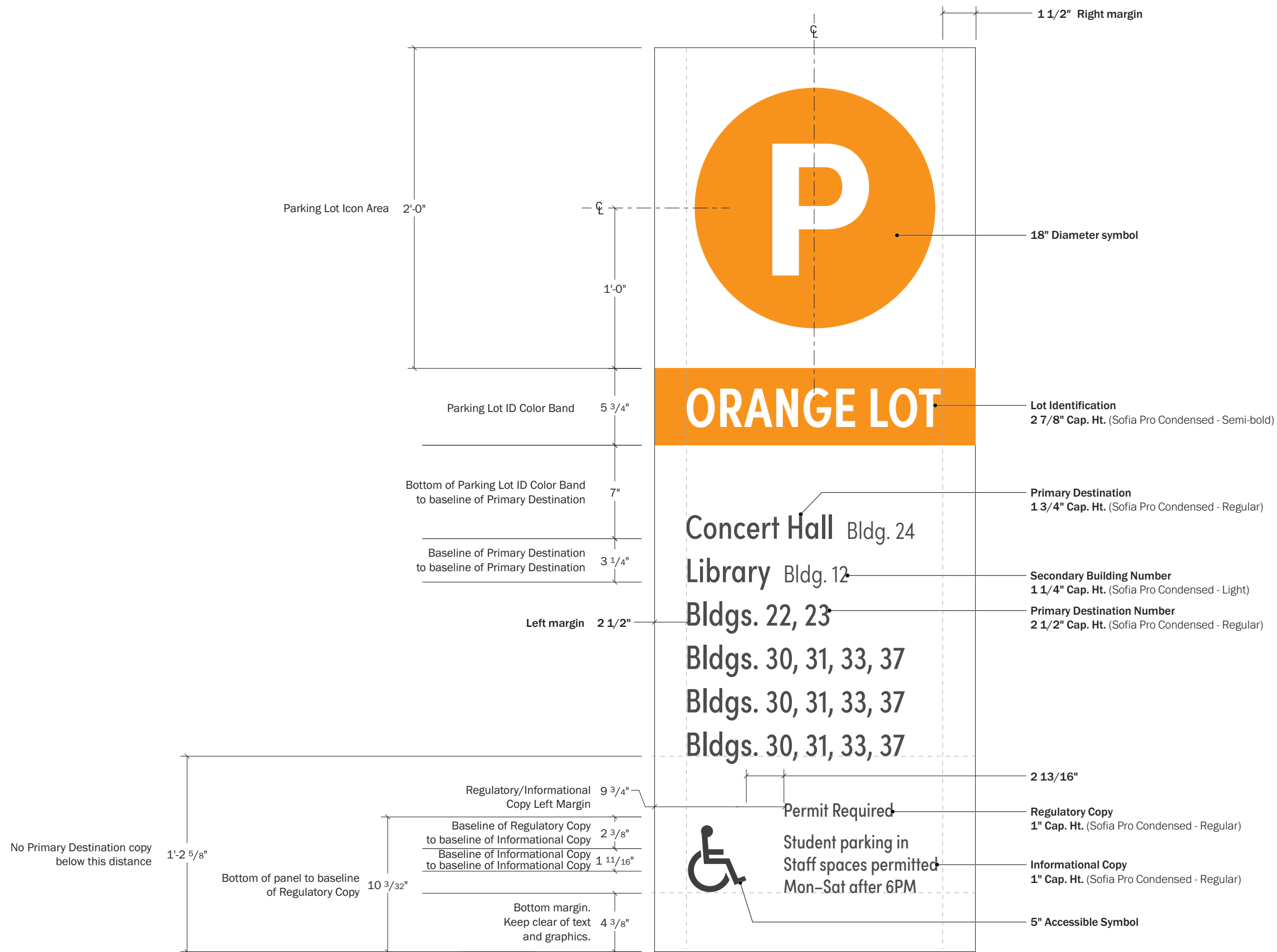


MiraCosta College District
Standards

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

Preliminary Signage Standards Manual



Panel Layout Dimensions
SCALE: 1 1/2" = 1'-0"

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**SIGN TYPE P1
MESSAGE LAYOUT**

MiraCosta College District
Standards

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

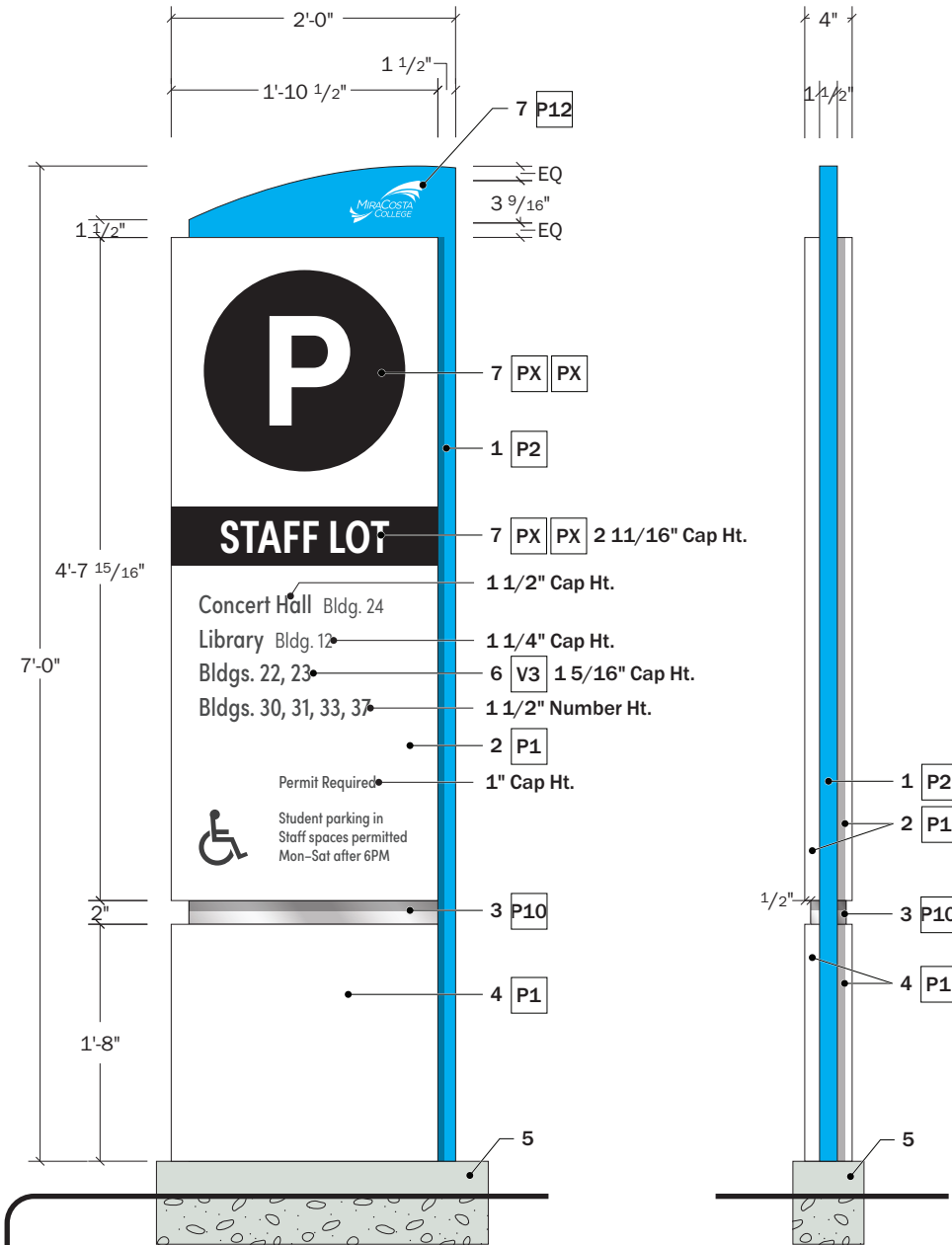
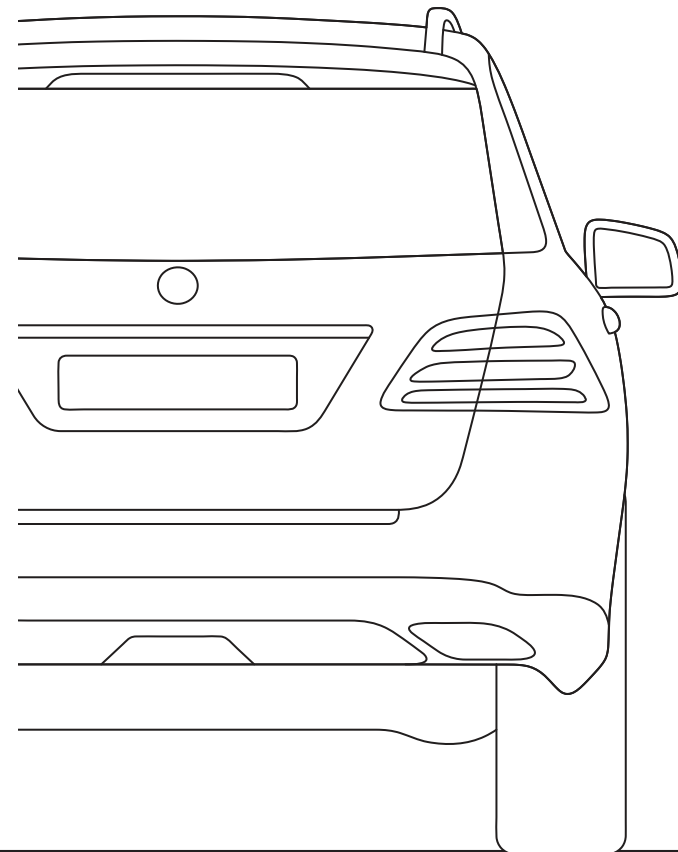
Preliminary Signage Standards Manual

DRAWING NOTES

- 1 Fabricated aluminum sign fin w/ internal rigid framing structure and paint finish on all sides. Curvature at top of fin to be the same for all versions of this sign type.
 - 2 Fabricated aluminum sign message panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns. Paint fasteners to match sign panel.
 - 3 Fabricated reveal w/ paint finish. Reveal to abut to surrounding sign components with no gaps.
 - 4 Fabricated aluminum sign footer panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns to provide maintenance access to footing connection. Paint fasteners to match sign panel.
 - 5 Concrete footing as required per Sign Fabricator's engineering. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
 - 6 Applied, premium grade vinyl lettering and symbols as noted. Vinyl is applied free of air bubbles, tears, folds, and creases.
 - 7 Masked and painted logo, graphics and text.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.



PLAN VIEW

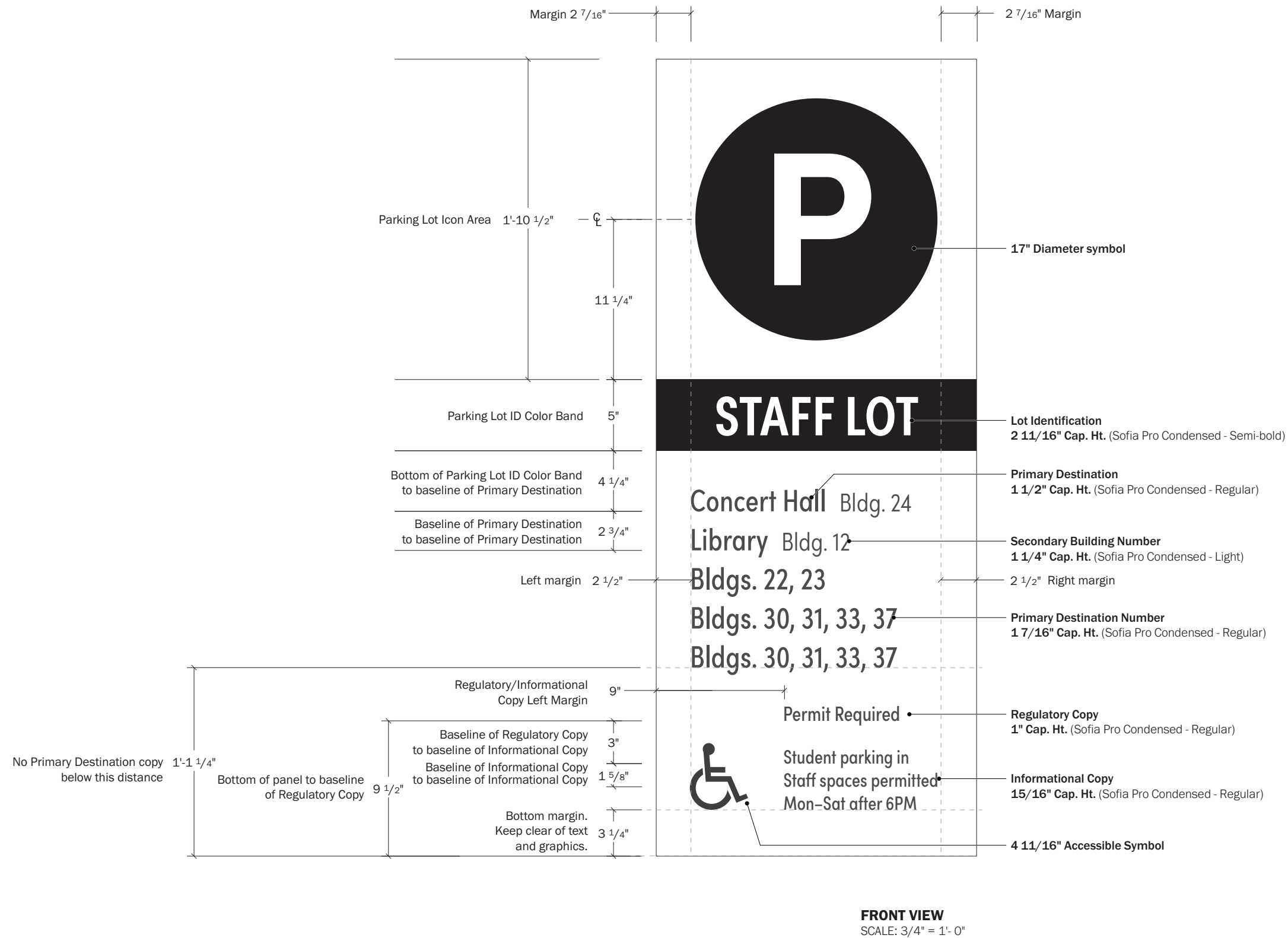


FRONT VIEW
SCALE: 3/4" = 1'-0"

SIDE VIEW

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE P2
SECONDARY PARKING LOT
IDENTIFICATION**



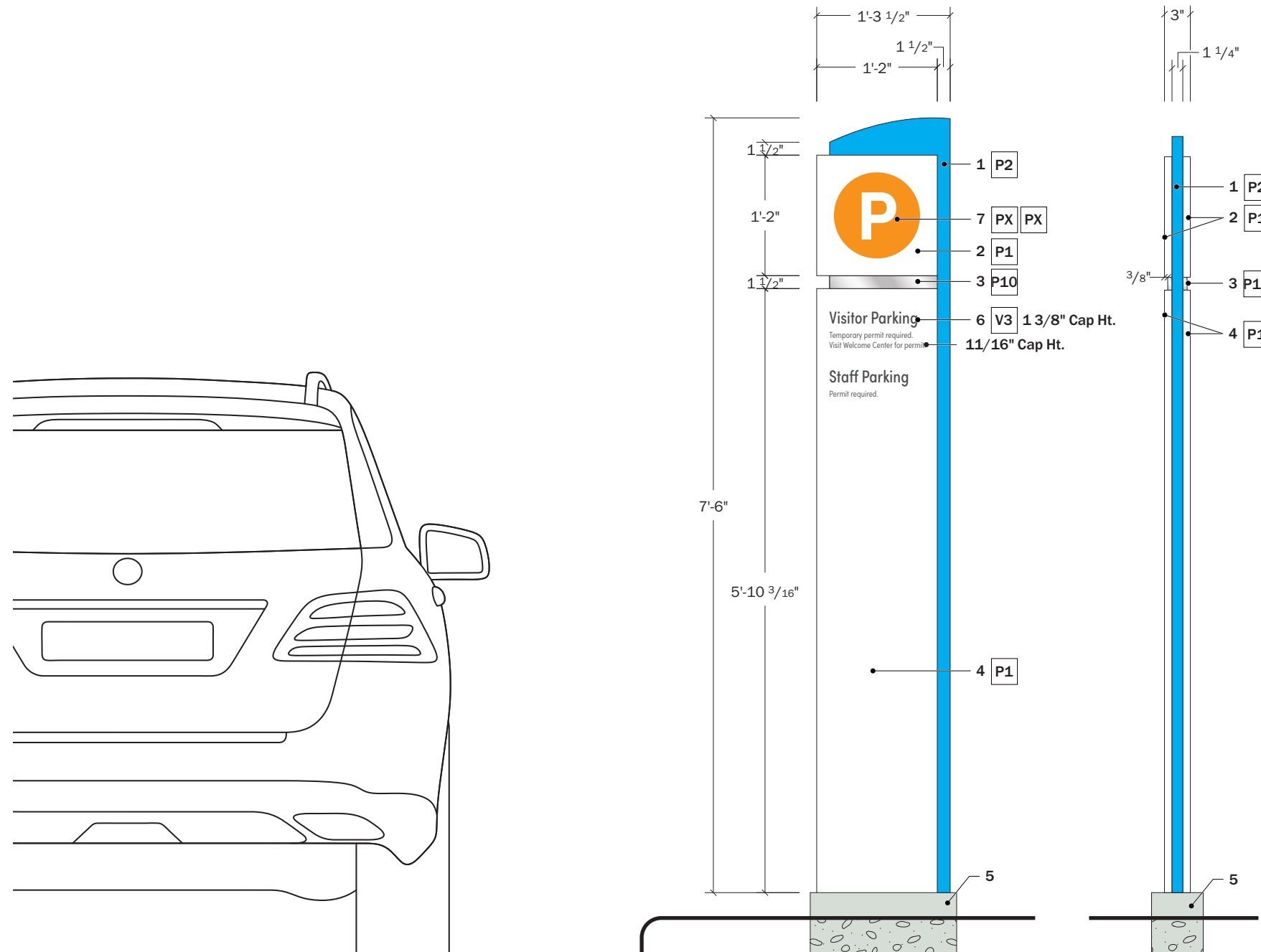
All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

MiraCosta College District
Standards

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

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Preliminary Signage Standards Manual



FRONT VIEW
SCALE: 3/4" = 1'-0"

SIDE VIEW

DRAWING NOTES

- 1 Fabricated aluminum sign fin w/ internal rigid framing structure and paint finish on all sides. Curvature at top of fin to be the same for all versions of this sign type.
- 2 Fabricated aluminum sign message panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns. Paint fasteners to match sign panel.
- 3 Fabricated reveal w/ paint finish. Reveal to abut to surrounding sign components with no gaps.
- 4 Fabricated aluminum sign footer message panel w/ internal rigid framing structure and paint finish on all sides. Faces of sign panel to be removable via tamper-proof, flathead mechanical fasteners on sign returns to provide maintenance access to footing connection. Paint fasteners to match sign panel.
- 5 Concrete footing as required per Sign Fabricator's engineering. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
- 6 Applied, premium grade vinyl lettering and symbols as noted. Vinyl is applied free of air bubbles, tears, folds, and creases.
- 7 Masked and painted logo, graphics and text.
- A Sign fabricator responsible for developing and providing stamped engineering drawings, detailing sign footing connection, concrete footing, and internal framing structure considering appropriate wind loads and sign weight.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

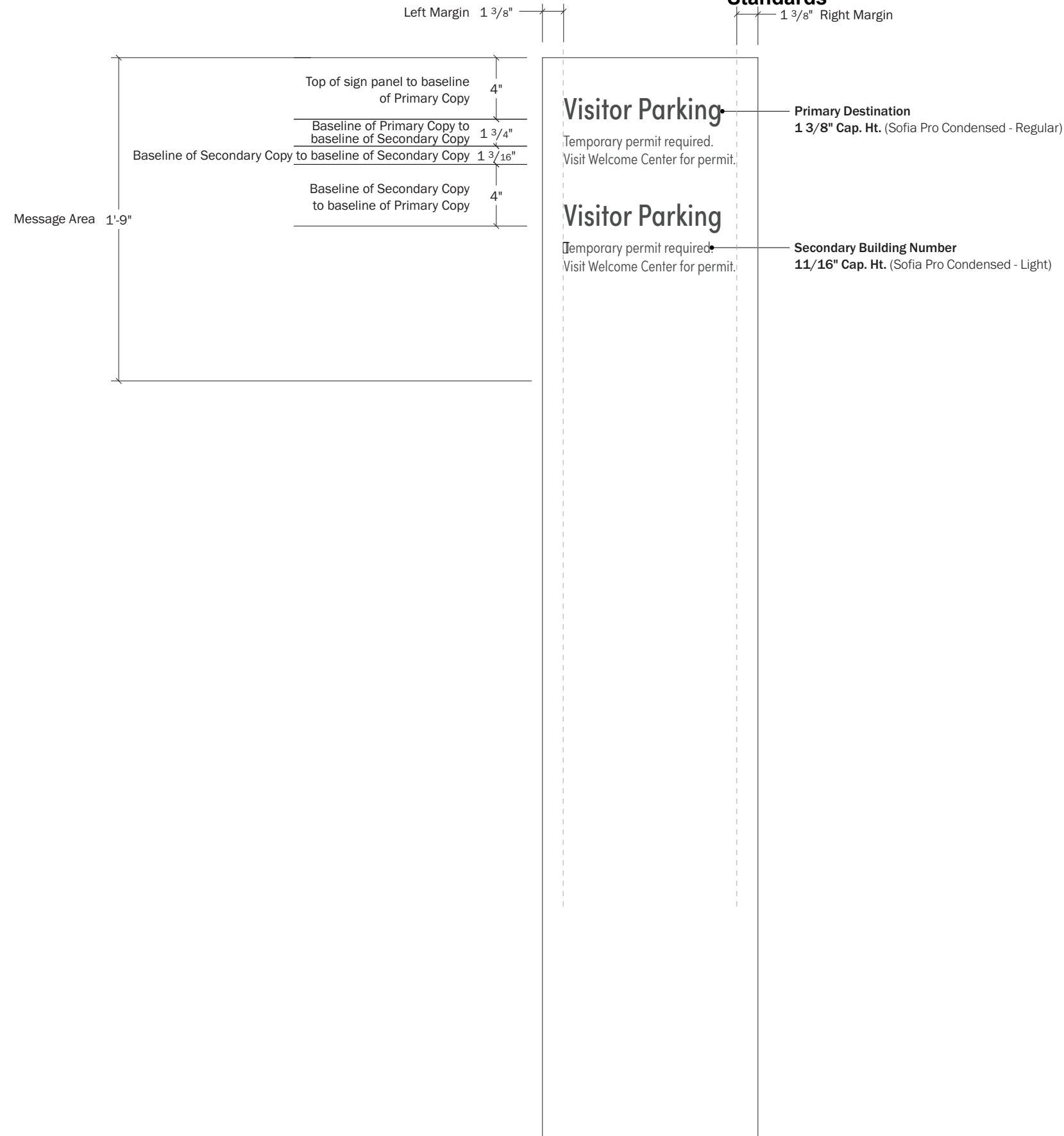
**SIGN TYPE P3
PARKING USER GROUP
IDENTIFICATION**

MiraCosta College District Standards

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

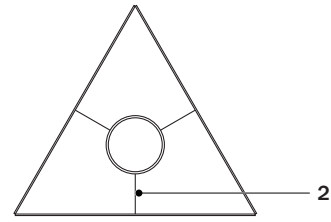
Preliminary Signage Standards Manual



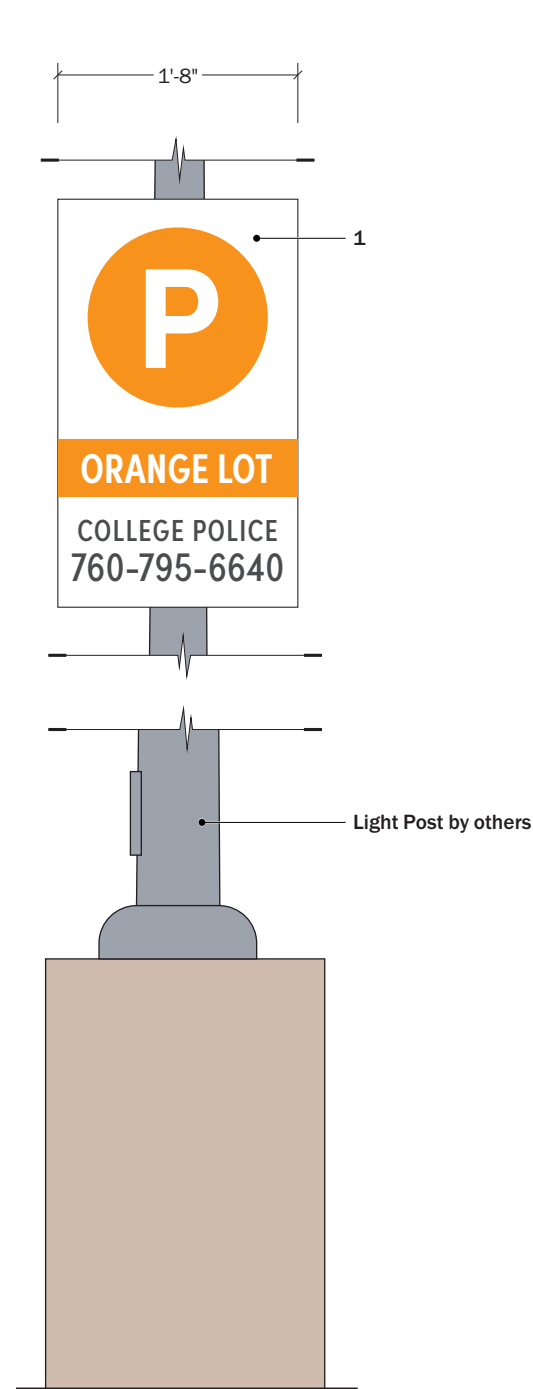
Panel Layout Dimension
SCALE: 1 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

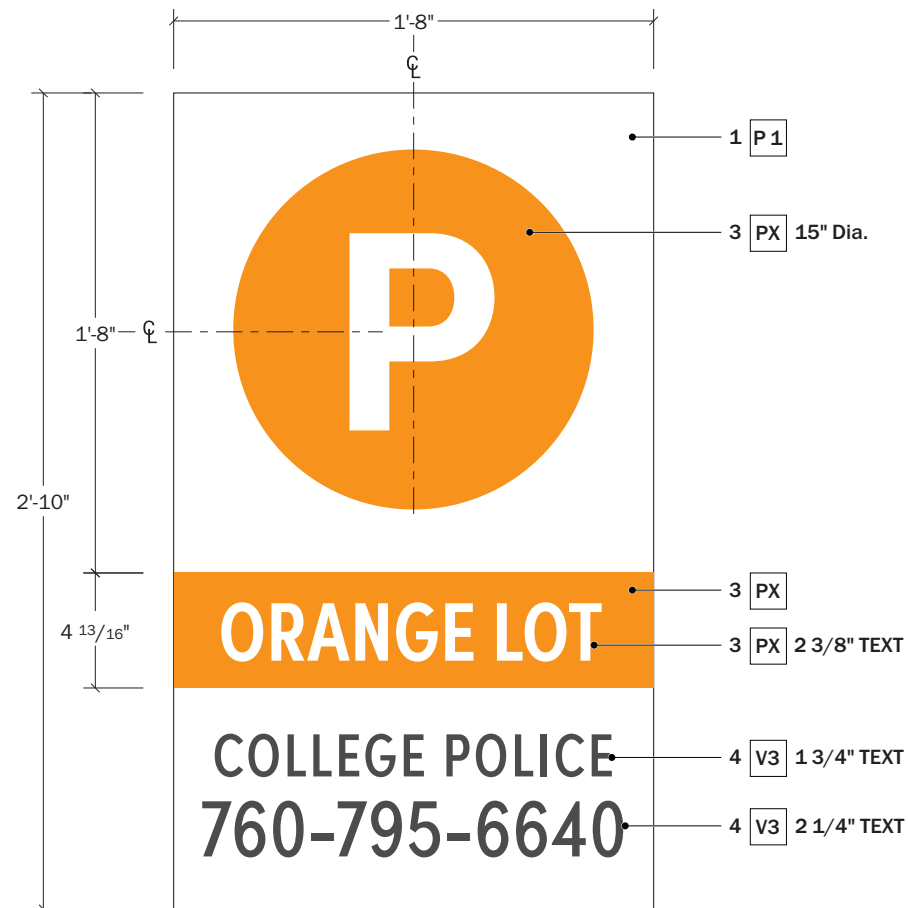
**SIGN TYPE P3
MESSAGE LAYOUT**



PLAN VIEW



FRONT VIEW
SCALE: 3/4" = 1'-0"



PANEL DETAIL
SCALE: 1 1/2" = 1'-0"

DRAWING NOTES

- 1 3/16" thick, aluminum sign panel with paint finish on all sides. Sign panel has masked and sprayed graphics and applied vinyl text. Sign consists of (3) panels mounted to light pole.
 - 2 Sign fabricator to develop mounting bracket(s) to support 3-sided sign around existing light poles. Mounting brackets should allow for adjustment in the field to accommodate discrepancies in light pole diameter. Mounting brackets to be secured to light poles with tension; penetrating light poles with mechanical fasteners is prohibited. Each sign location should include a minimum of (2) connection points to light poles. Sign panels to be fastened to mounting brackets with mechanical fasteners concealed from sign faces. Mounting bracket and attachment method should account for appropriate wind loads to prevent sign from detaching and/or spinning/rotating on pole.
 - 3 Masked and painted graphics on sign panels.
 - 4 Applied vinyl graphic text on sign panels.
- A Confirm sign message and phone number with College prior to shop drawings.
- B Signs are 3-sided. This should be considered when providing a bid.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

SIGN TYPE P4
PARKING LOT IDENTIFICATION
(LIGHT POLE MOUNTED)

MiraCosta College District
Standards

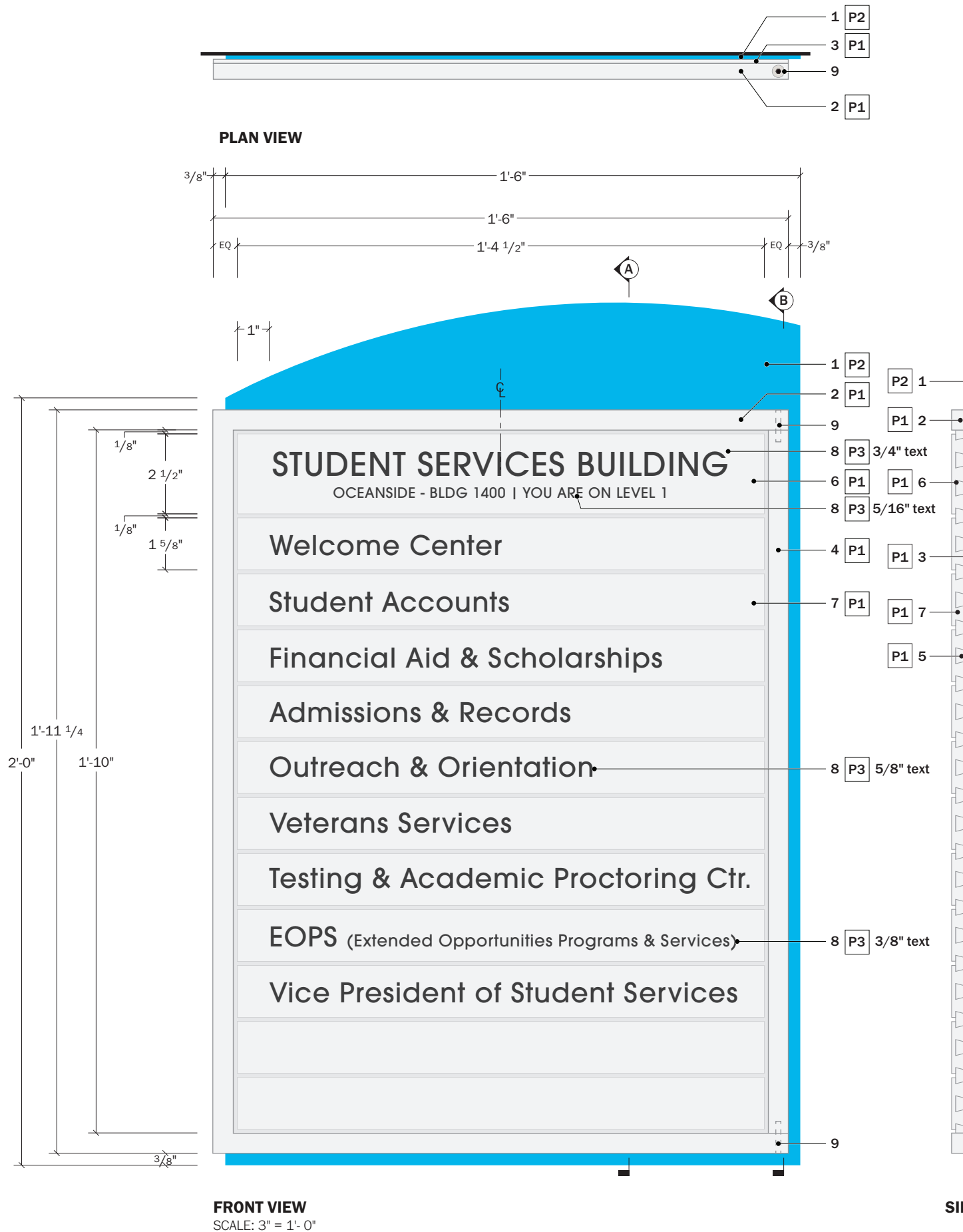
**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

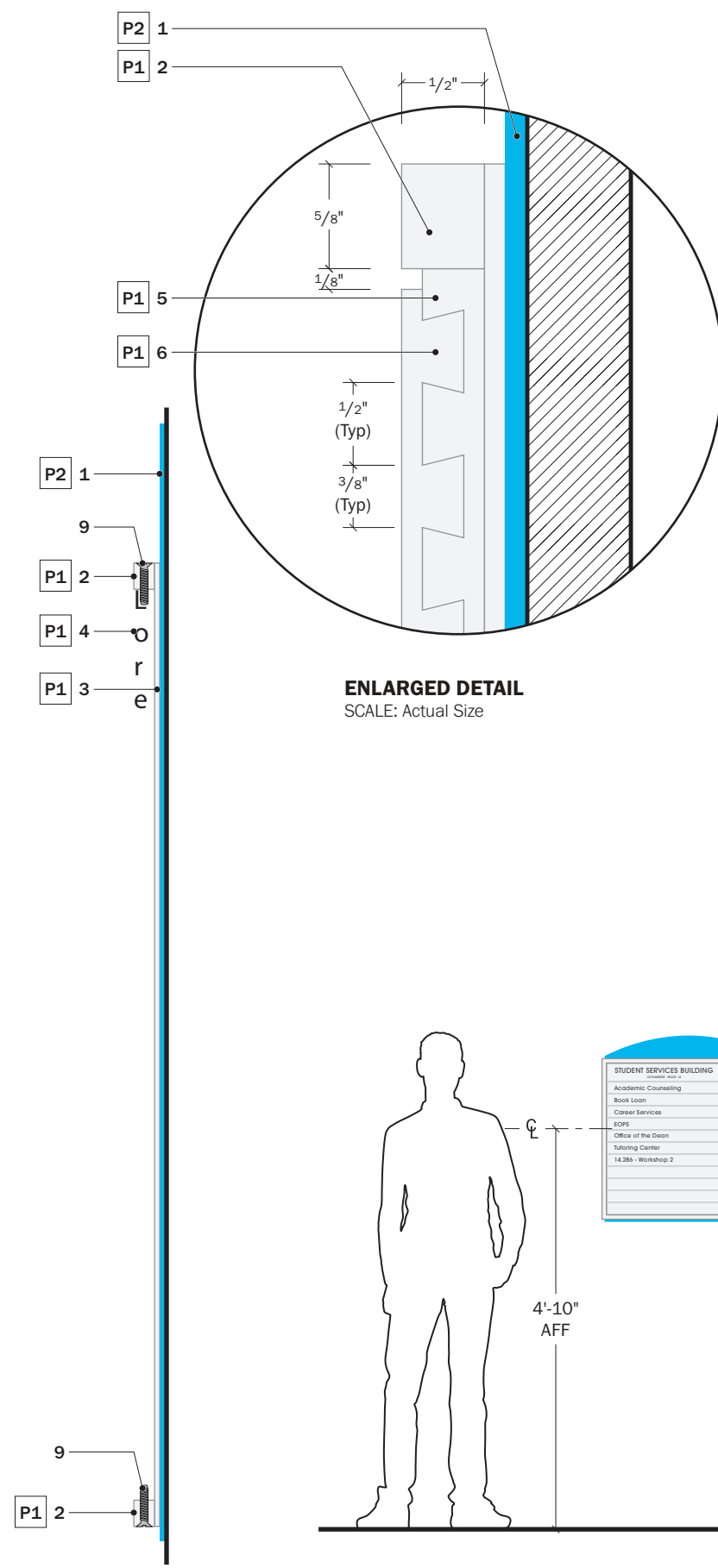
Preliminary Signage Standards Manual

DRAWING NOTES

- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 Fabricated aluminum frame with paint finish. Frame has removable side, as indicated, secured in place with (2) counter-set, set screws. Frame face is flush with sign message insert panels. Frame is secured to frame backer panel with thin VHB tape and adhesive as required to prevent detachment.
 - 3 1/8" thick, acrylic frame backer glued to aluminum frame (noted above). Backer has paint finish on all sides.
 - 4 Removable edge of aluminum frame. Piece is secured with set-screws at top and bottom.
 - 5 Fabricated message panel holder. 3/8" thick acrylic, with dove-tail routed grooves at regular intervals. Grooves host message panels by allowing them to slide into dove-tail easily. Paint finish on all exposed sides. Message panel holder to be precisely machined so that message panels are held in place plumb without tilting.
 - 6 Header Panel - 3/8" thick acrylic with dove-tail routed grooves to slide into message panel holder easily. Message panel to have paint finish on sides. Silk-screened lettering on header panel face. Panel to be precisely machined to allow for easy slide into any similar sign type on campus. Panels are intended to be interchangeable.
 - 7 Message Panel - see note above.
 - 8 Silk-screened lettering and symbols per message schedule on message and header panels.
 - 9 Counter-sunk, hex set-screw. Screw should be readily available for replacements in the future.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B Sign fabricator to develop details in shop drawings for review.
- C Sign panel sizes to be determined by each sign location's message. Small message panels are to be used as spacers between different directional copy and used as fillers if necessary.



FRONT VIEW
SCALE: 3" = 1'-0"



ENLARGED DETAIL
SCALE: Actual Size

MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

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**SIGN TYPE E1
DEPARTMENT DIRECTORY**

MiraCosta College District
Standards

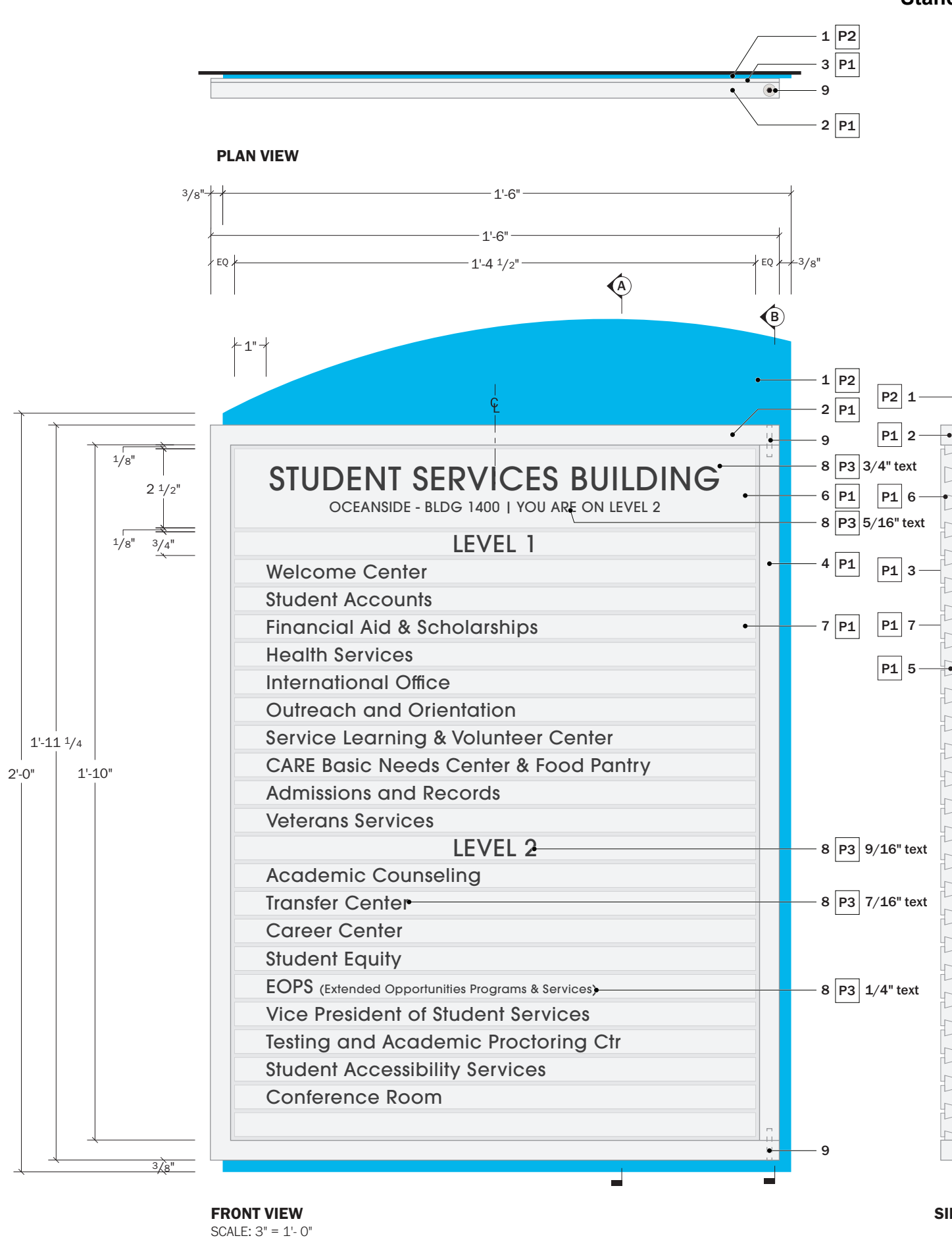
**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

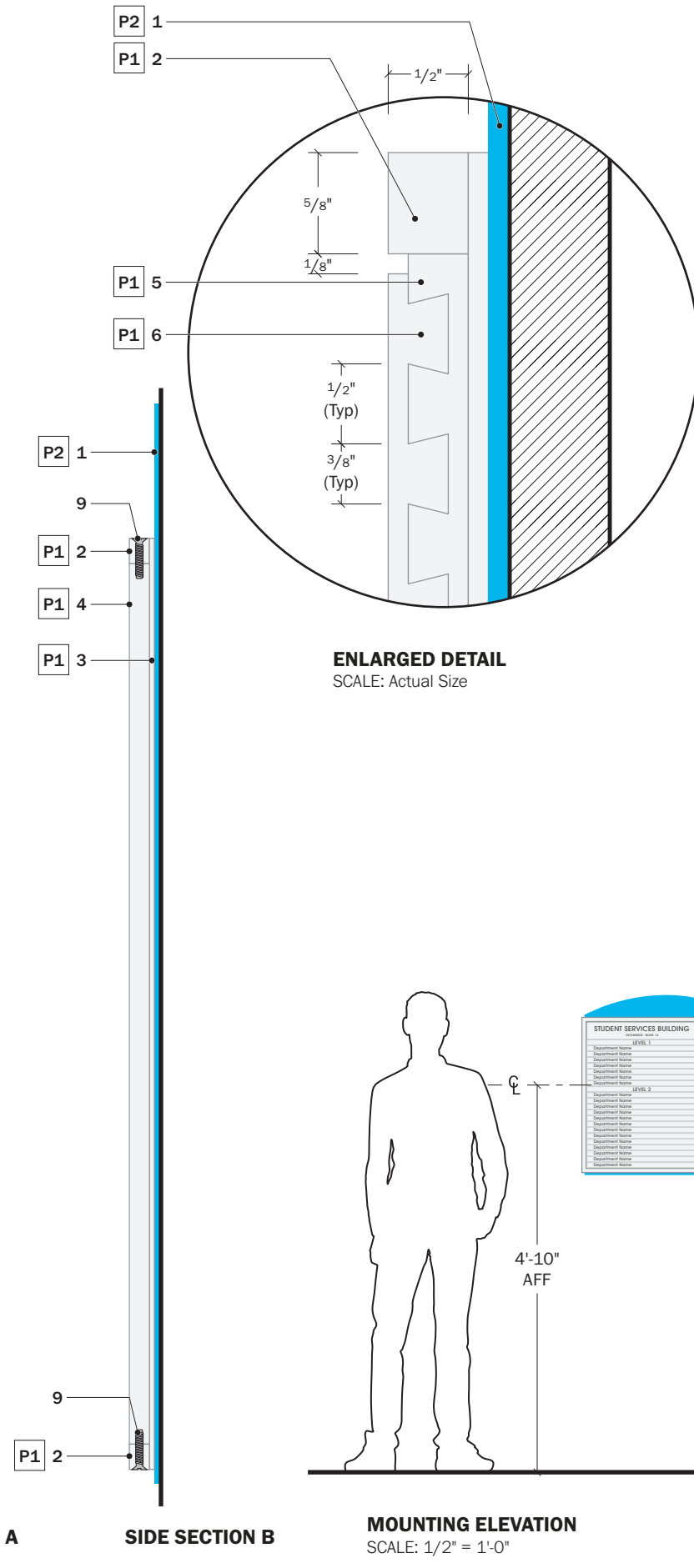
Preliminary Signage Standards Manual

DRAWING NOTES

- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 Fabricated aluminum frame with paint finish. Frame has removable side, as indicated, secured in place with (2) counter-set, set screws. Frame face is flush with sign message insert panels. Frame is secured to frame backer panel with thin VHB tape and adhesive as required to prevent detachment.
 - 3 1/8" thick, acrylic frame backer glued to aluminum frame (noted above). Backer has paint finish on all sides.
 - 4 Removable edge of aluminum frame. Piece is secured with set-screws at top and bottom.
 - 5 Fabricated message panel holder. 3/8" thick acrylic, with dove-tail routed grooves at regular intervals. Grooves host message panels by allowing them to slide into dove-tail easily. Paint finish on all exposed sides. Message panel holder to be precisely machined so that message panels are held in place plumb without tilting.
 - 6 Header Panel - 3/8" thick acrylic with dove-tail routed grooves to slide into message panel holder easily. Message panel to have paint finish on sides. Silk-screened lettering on header panel face. Panel to be precisely machined to allow for easy slide into any similar sign type on campus. Panels are intended to be interchangeable.
 - 7 Message Panel - see note above.
 - 8 Silk-screened lettering and symbols per message schedule on message and header panels.
 - 9 Counter-sunk, hex set-screw. Screw should be readily available for replacements in the future.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B Sign fabricator to develop details in shop drawings for review.
- C Sign panel sizes to be determined by each sign location's message. Small message panels are to be used as spacers between different directional copy and used as fillers if necessary.



FRONT VIEW
SCALE: 3" = 1'-0"



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

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**SIGN TYPE E2
BUILDING DIRECTORY
(MEDIUM)**

MiraCosta College District
Standards

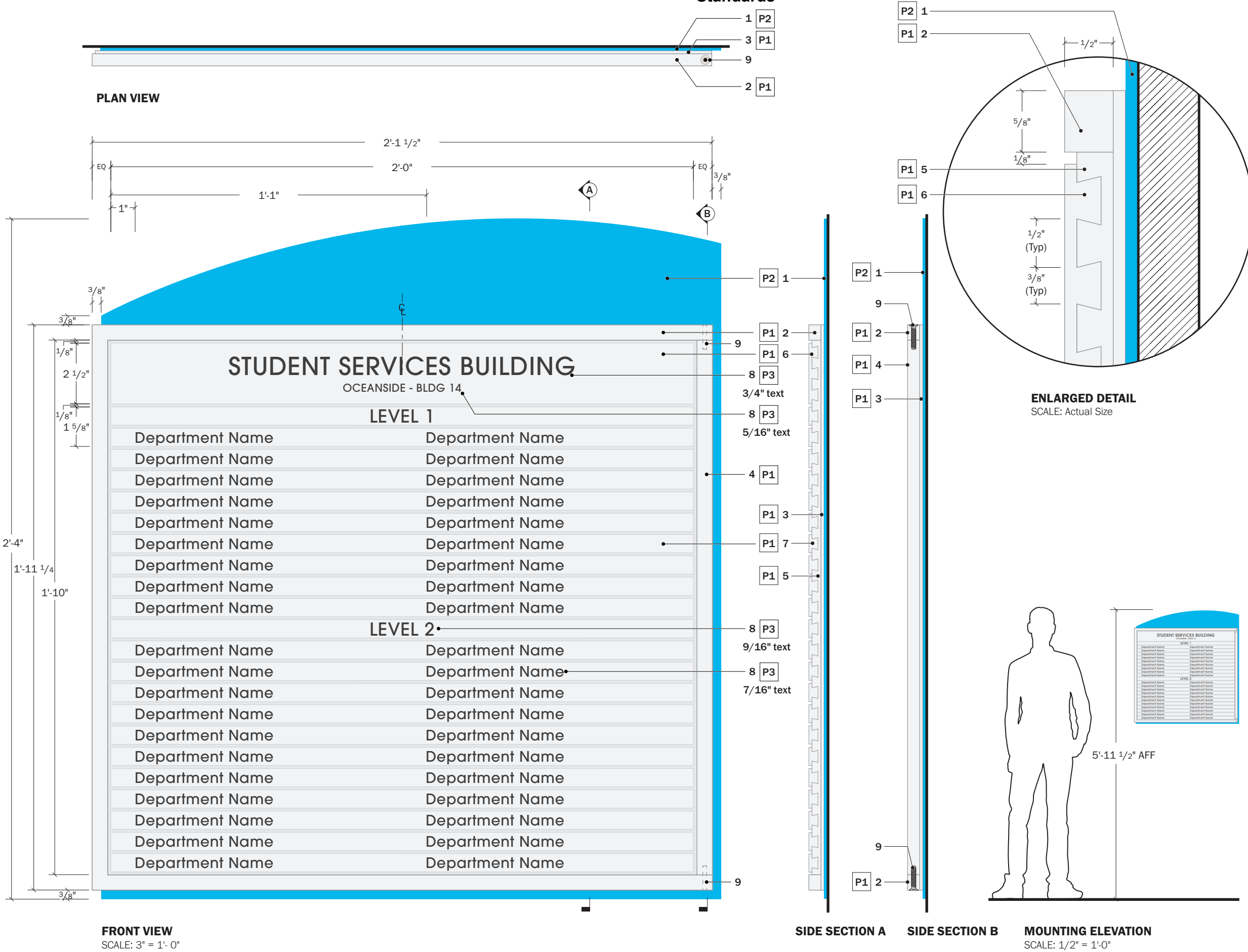
**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

Preliminary Signage Standards Manual

DRAWING NOTES

- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top. Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 Fabricated aluminum frame with paint finish. Frame has removable side, as indicated, secured in place with (2) counter-set, set screws. Frame face is flush with sign message insert panels. Frame is secured to frame backer panel with thin VHB tape and adhesive as required to prevent detachment.
 - 3 1/8" thick, acrylic frame backer glued to aluminum frame (noted above). Backer has paint finish on all sides.
 - 4 Removable edge of aluminum frame. Piece is secured with set-screws at top and bottom.
 - 5 Fabricated message panel holder. 3/8" thick acrylic, with dove-tail routed grooves at regular intervals. Grooves host message panels by allowing them to slide into dove-tail easily. Paint finish on all exposed sides. Message panel holder to be precisely machined so that message panels are held in place plumb without tilting.
 - 6 Header Panel - 3/8" thick acrylic with dove-tail routed grooves to slide into message panel holder easily. Message panel to have paint finish on sides. Silk-screened lettering on header panel face. Panel to be precisely machined to allow for easy slide into any similar sign type on campus. Panels are intended to be interchangeable.
 - 7 Message Panel - see note above.
 - 8 Silk-screened lettering and symbols per message schedule on message and header panels.
 - 9 Counter-sunk, hex set-screw. Screw should be readily available for replacements in the future.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B Sign fabricator to develop details in shop drawings for review.
- C Sign panel sizes to be determined by each sign location's message. Small message panels are to be used as spacers between different directional copy and used as fillers if necessary.

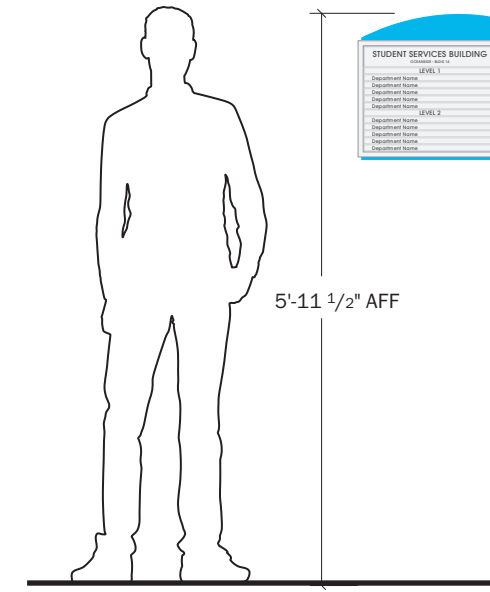
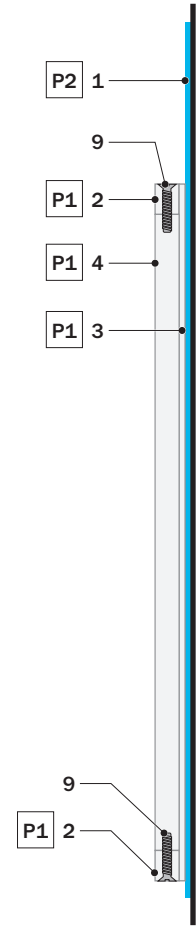
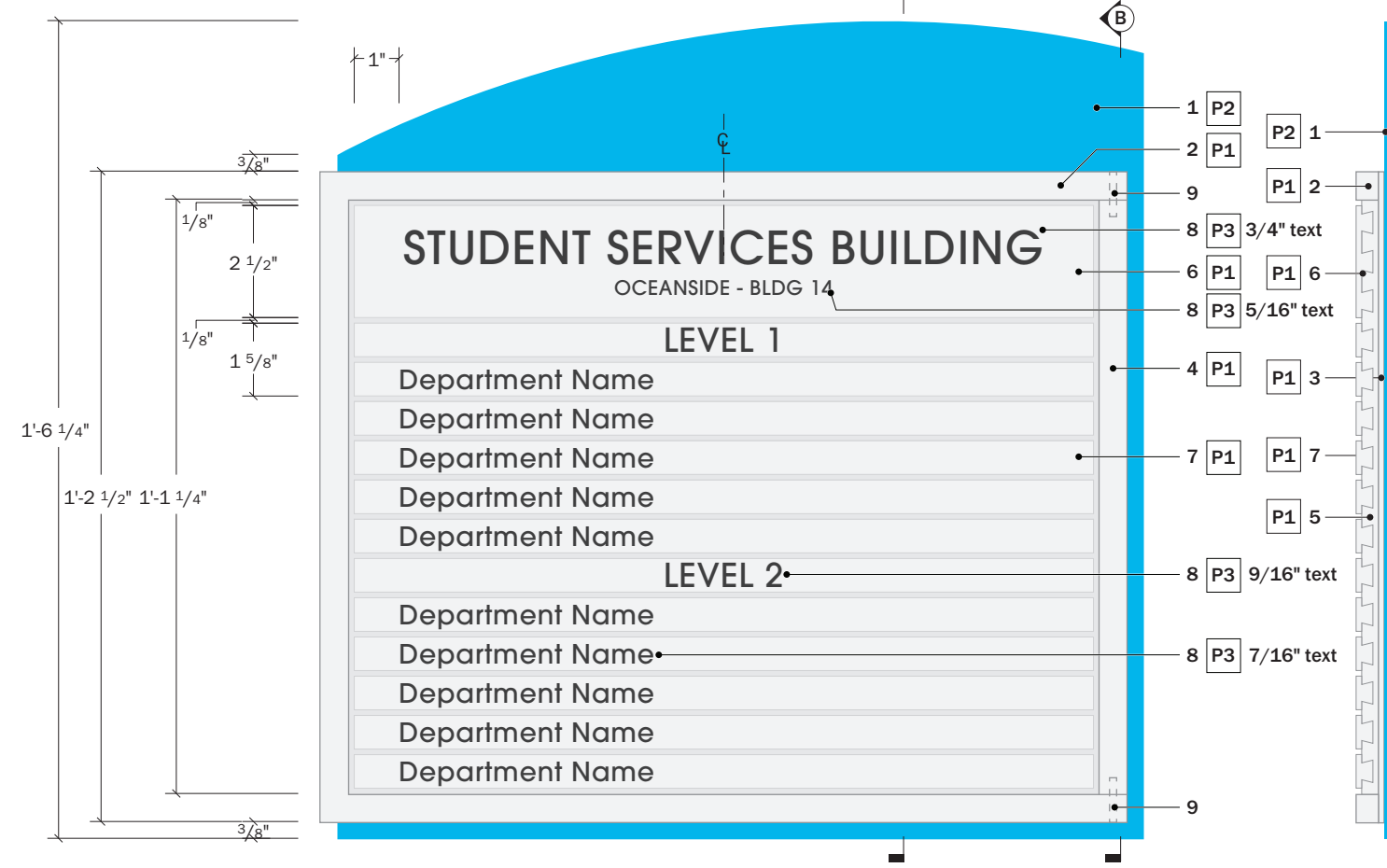
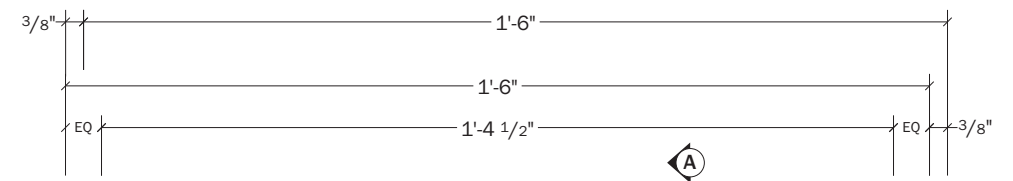
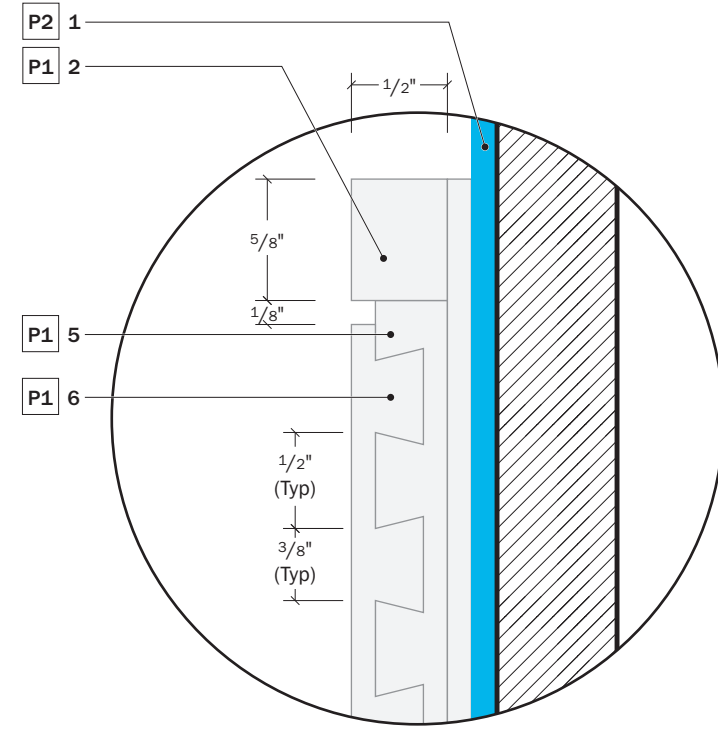


All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE E2.1
BUILDING DIRECTORY (LARGE)**

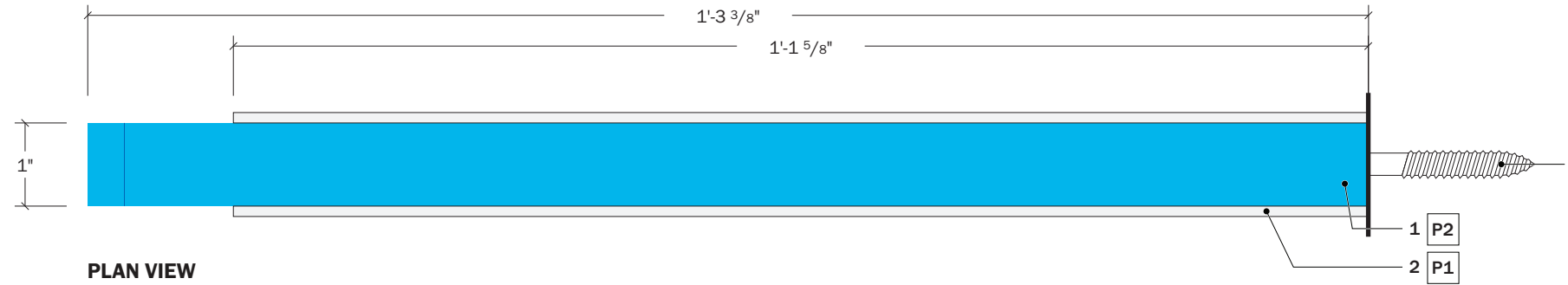
DRAWING NOTES

- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
- 2 Fabricated aluminum frame with paint finish. Frame has removable side, as indicated, secured in place with (2) counter-set, set screws. Frame face is flush with sign message insert panels. Frame is secured to frame backer panel with thin VHB tape and adhesive as required to prevent detachment.
- 3 1/8" thick, acrylic frame backer glued to aluminum frame (noted above). Backer has paint finish on all sides.
- 4 Removable edge of aluminum frame. Piece is secured with set-screws at top and bottom.
- 5 Fabricated message panel holder. 3/8" thick acrylic, with dove-tail routed grooves at regular intervals. Grooves host message panels by allowing them to slide into dove-tail easily. Paint finish on all exposed sides. Message panel holder to be precisely machined so that message panels are held in place plumb without tilting.
- 6 Header Panel - 3/8" thick acrylic with dove-tail routed grooves to slide into message panel holder easily. Message panel to have paint finish on sides. Silk-screened lettering on header panel face. Panel to be precisely machined to allow for easy slide into any similar sign type on campus. Panels are intended to be interchangeable.
- 7 Message Panel - see note above.
- 8 Silk-screened lettering and symbols per message schedule on message and header panels.
- 9 Counter-sunk, hex set-screw. Screw should be readily available for replacements in the future.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B Sign fabricator to develop details in shop drawings for review.
- C Sign panel sizes to be determined by each sign location's message. Small message panels are to be used as spacers between different directional copy and used as fillers if necessary.

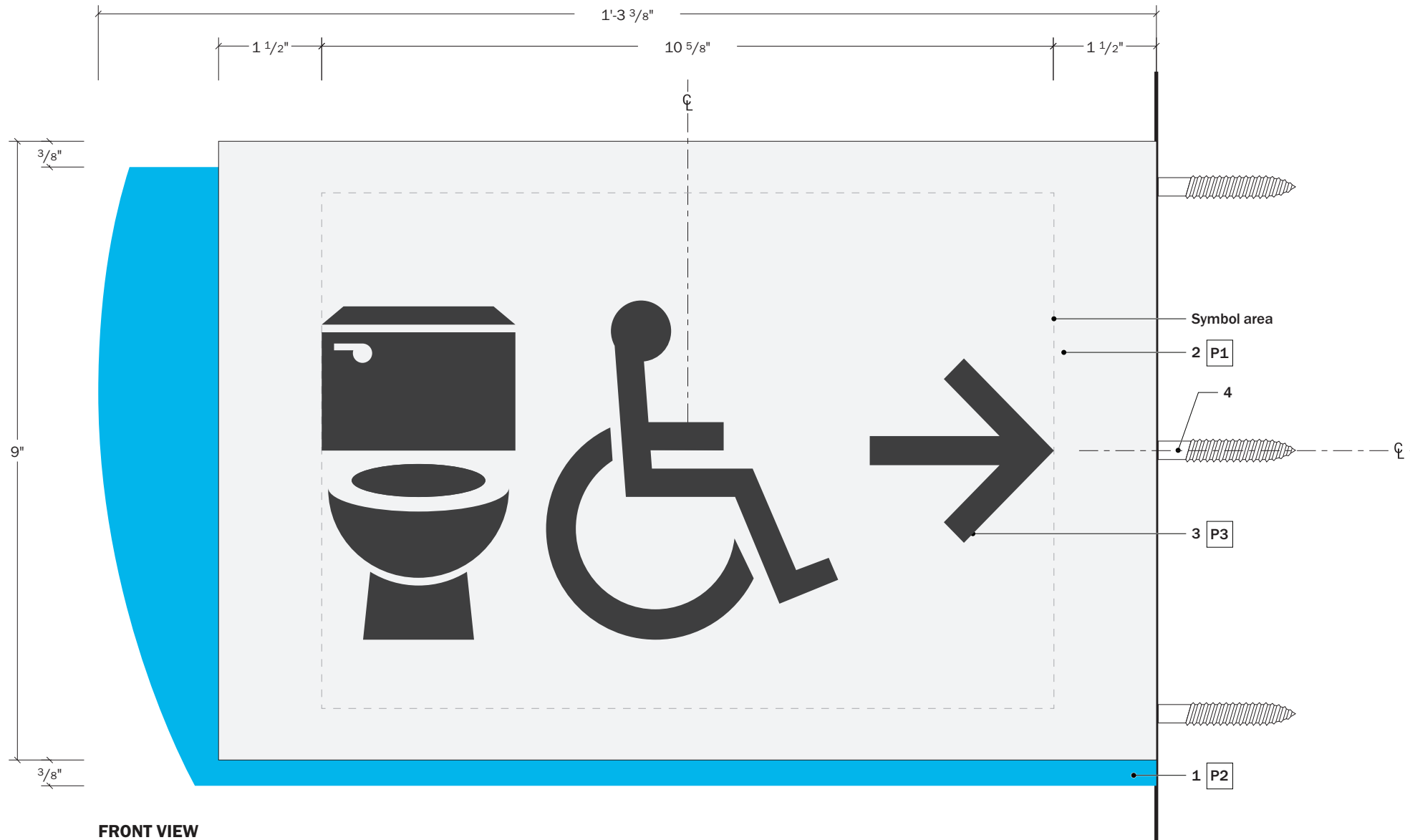


**SIGN TYPE E2.2
BUILDING DIRECTORY (SMALL)**

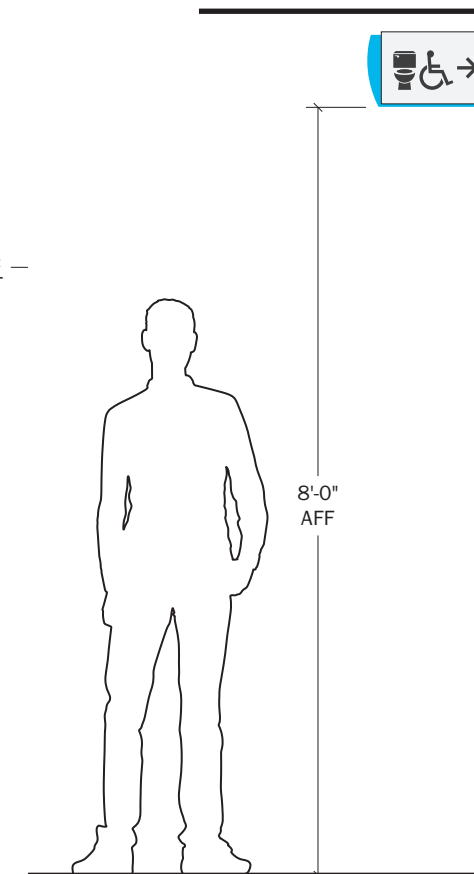
All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.



PLAN VIEW



FRONT VIEW
SCALE: Half Size



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

DRAWING NOTES

- 1 1" Thick fabricated sign core with paint finish on all sides. Sign core has curved edge as shown in drawing. Curve to be smooth with welds ground and finished. Sign core has concealed mounting attachment to wall. Sign fabricator to develop mounting for review in shop drawings. Mounting conditions may vary -- Sign fabricator to confirm all locations prior to shop drawings.
 - 2 1/8" Thick aluminum face panels with paint finish on all sides. Face panels are adhered to sign core with full coverage adhesive.
 - 3 Silk-screened symbol on face panel. Signs are double-sided. Refer to message schedule for sign message.
 - 4 Mounting hardware as required to secure sign to wall surface. Sign fabricator to field verify all locations prior to install to determine appropriate hardware. No exposed fasteners allowed.
- A Sign fabricator to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B Sign fabricator to confirm mounting heights are permitted with ceiling heights at each location prior to install.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE F3
BLADE DIRECTIONAL**

MiraCosta College District
Standards

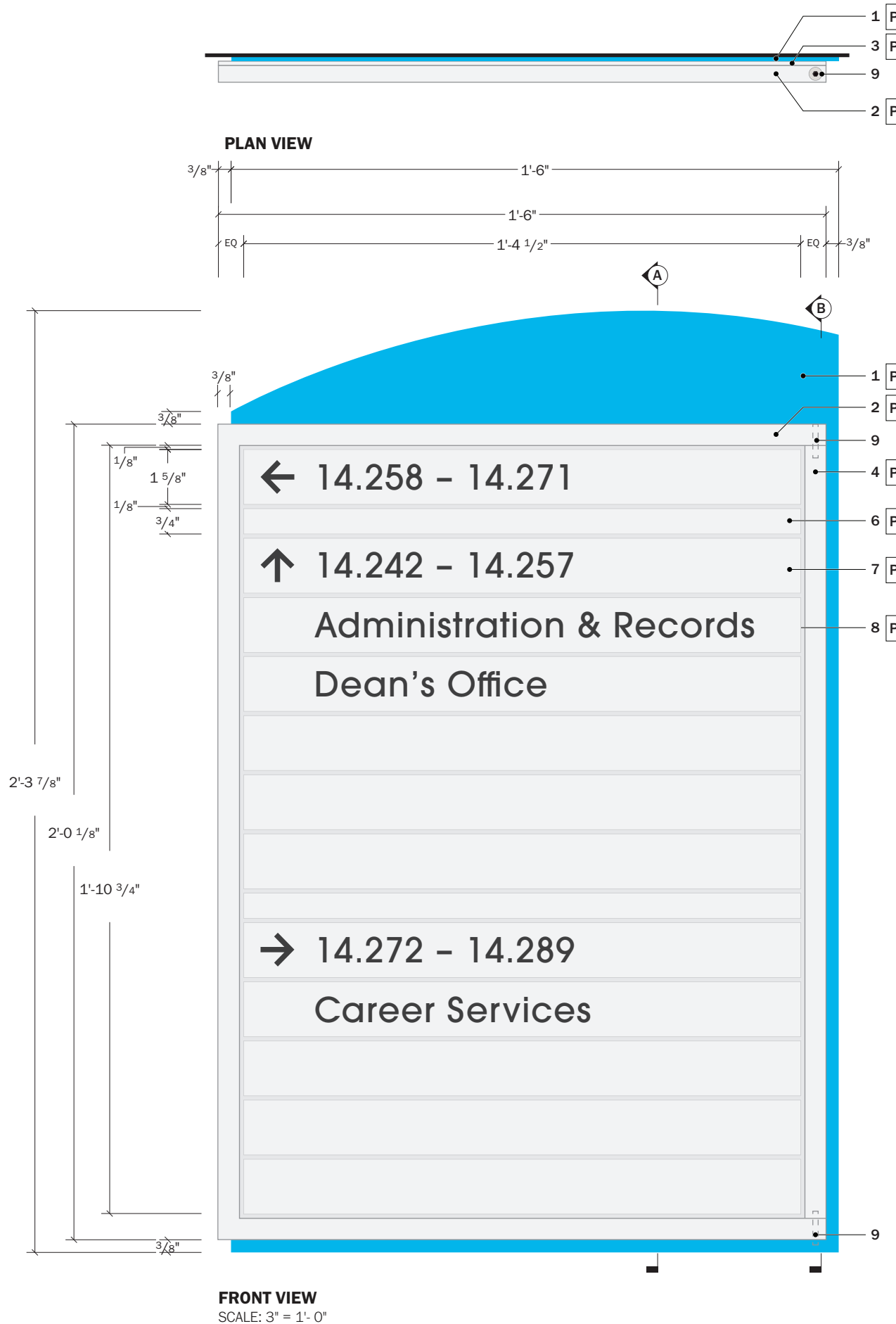
**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

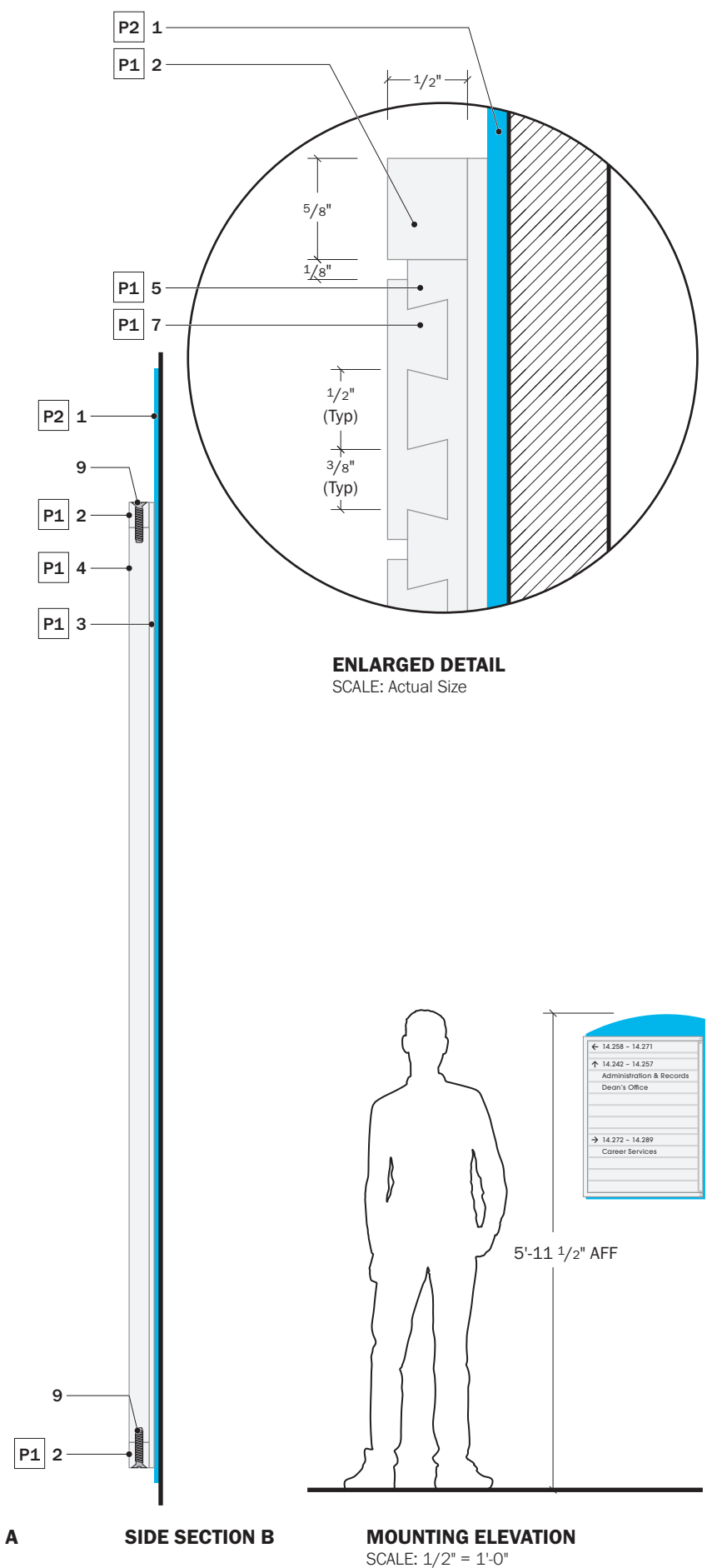
Preliminary Signage Standards Manual

DRAWING NOTES

- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 Fabricated aluminum frame with paint finish. Frame has removable side, as indicated, secured in place with (2) counter-set, set screws. Frame face is flush with sign message insert panels. Frame is secured to frame backer panel with thin VHB tape and adhesive as required to prevent detachment.
 - 3 1/8" thick, acrylic frame backer glued to aluminum frame (noted above). Backer has paint finish on all sides.
 - 4 Removable edge of aluminum frame. Piece is secured with set-screws at top and bottom.
 - 5 Fabricated message panel holder. 3/8" thick acrylic, with dove-tail routed grooves at regular intervals. Grooves host message panels by allowing them to slide into dove-tail easily. Paint finish on all exposed sides. Message panel holder to be precisely machined so that message panels are held in place plumb without tilting.
 - 6 Message Panel Small - 3/8" thick acrylic with dove-tail routed grooves to slide into message panel holder easily. Message panel to have paint finish on sides. Silk-screened lettering on message panel face. Message panels to be precisely machined so they can easily slide into any similar sign type on campus. Panels are intended to be interchangeable.
 - 7 Message Panel Large - see note above.
 - 8 Silk-screened lettering and symbols per message schedule on message panels.
 - 9 Counter-sunk, hex set-screw. Screw should be readily available for replacements in the future.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B Sign fabricator to develop details in shop drawings for review.
- C Sign panel sizes to be determined by each sign location's message. Small message panels are to be used as spacers between different directional copy and used as fillers if necessary.



FRONT VIEW
SCALE: 3" = 1'-0"



SIDE SECTION A

SIDE SECTION B

MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

ENLARGED DETAIL
SCALE: Actual Size

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE F4
CORRIDOR DIRECTIONAL
(LARGE)**

MiraCosta College District
Standards

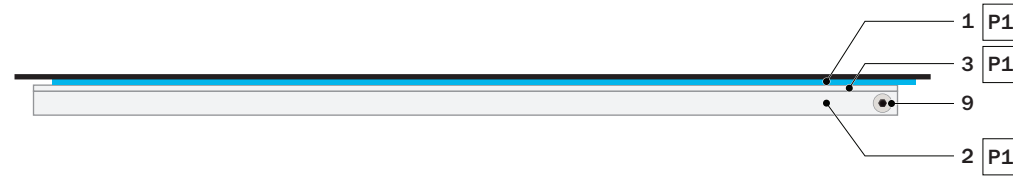
**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

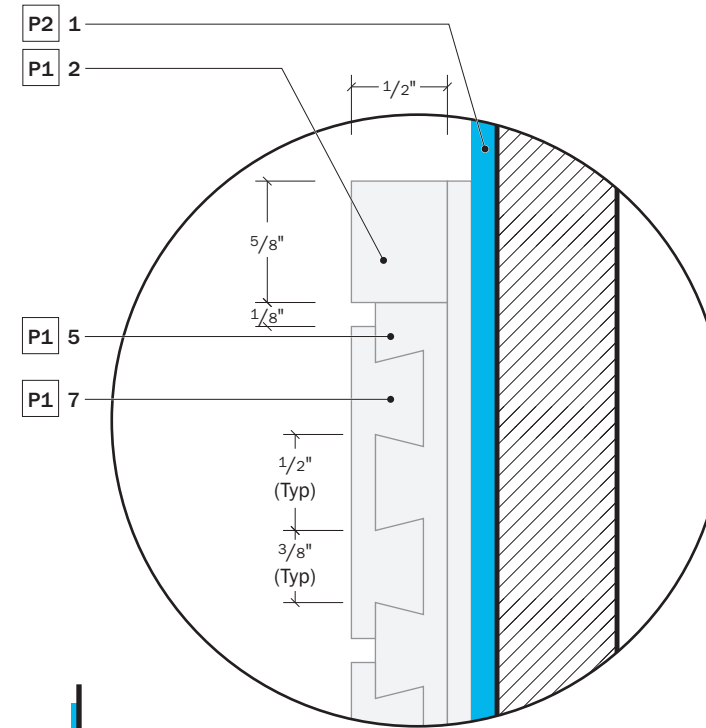
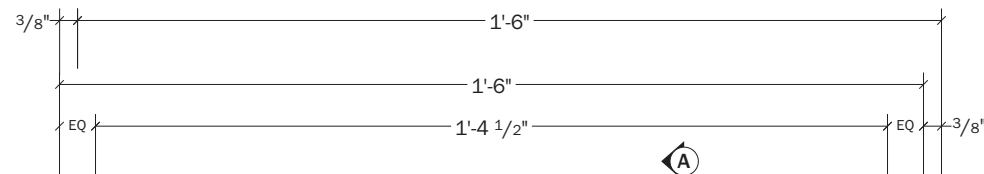
Preliminary Signage Standards Manual

DRAWING NOTES

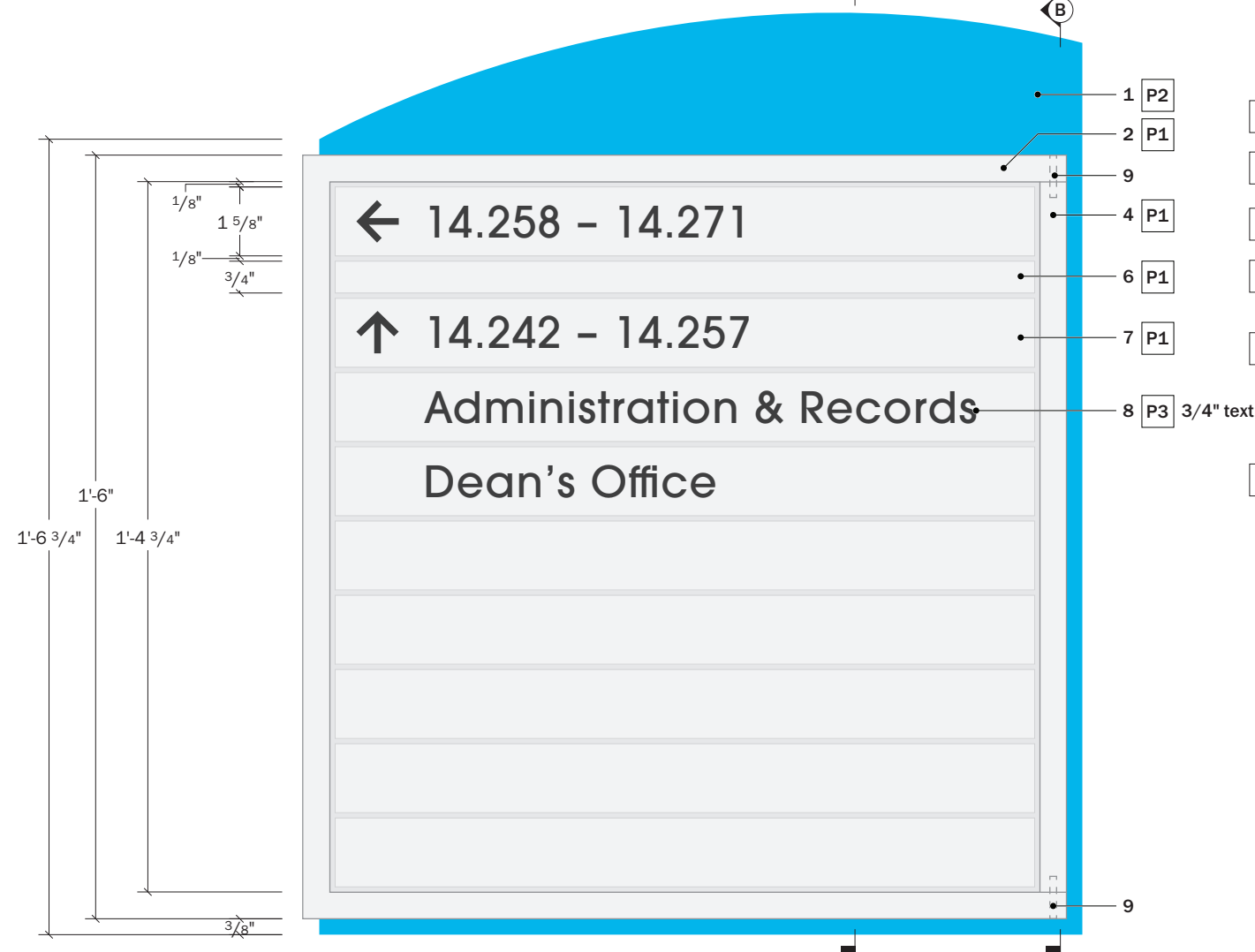
- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 Fabricated aluminum frame with paint finish. Frame has removable side, as indicated, secured in place with (2) counter-set, set screws. Frame face is flush with sign message insert panels. Frame is secured to frame backer panel with thin VHB tape and adhesive as required to prevent detachment.
 - 3 1/8" thick, acrylic frame backer glued to aluminum frame (noted above). Backer has paint finish on all sides.
 - 4 Removable edge of aluminum frame. Piece is secured with set-screws at top and bottom.
 - 5 Fabricated message panel holder. 3/8" thick acrylic, with dove-tail routed grooves at regular intervals. Grooves host message panels by allowing them to slide into dove-tail easily. Paint finish on all exposed sides. Message panel holder to be precisely machined so that message panels are held in place plumb without tilting.
 - 6 Message Panel Small - 3/8" thick acrylic with dove-tail routed grooves to slide into message panel holder easily. Message panel to have paint finish on sides. Silk-screened lettering on message panel face. Message panels to be precisely machined so they can easily slide into any similar sign type on campus. Panels are intended to be interchangeable.
 - 7 Message Panel Large - see note above.
 - 8 Silk-screened lettering and symbols per message schedule on message panels.
 - 9 Counter-sunk, hex set-screw. Screw should be readily available for replacements in the future.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B Sign fabricator to develop details in shop drawings for review.
- C Sign panel sizes to be determined by each sign location's message. Small message panels are to be used as spacers between different directional copy and used as fillers if necessary.



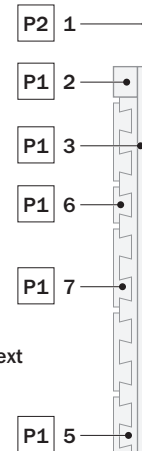
PLAN VIEW



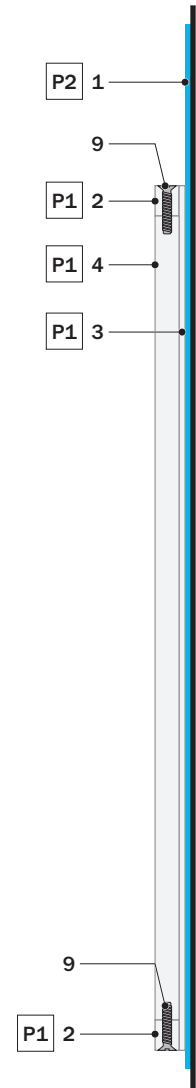
ENLARGED DETAIL
SCALE: Actual Size



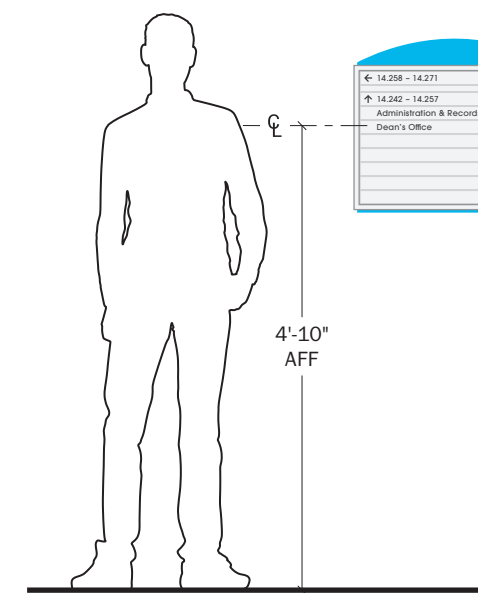
FRONT VIEW
SCALE: 3" = 1'-0"



SIDE SECTION A



SIDE SECTION B



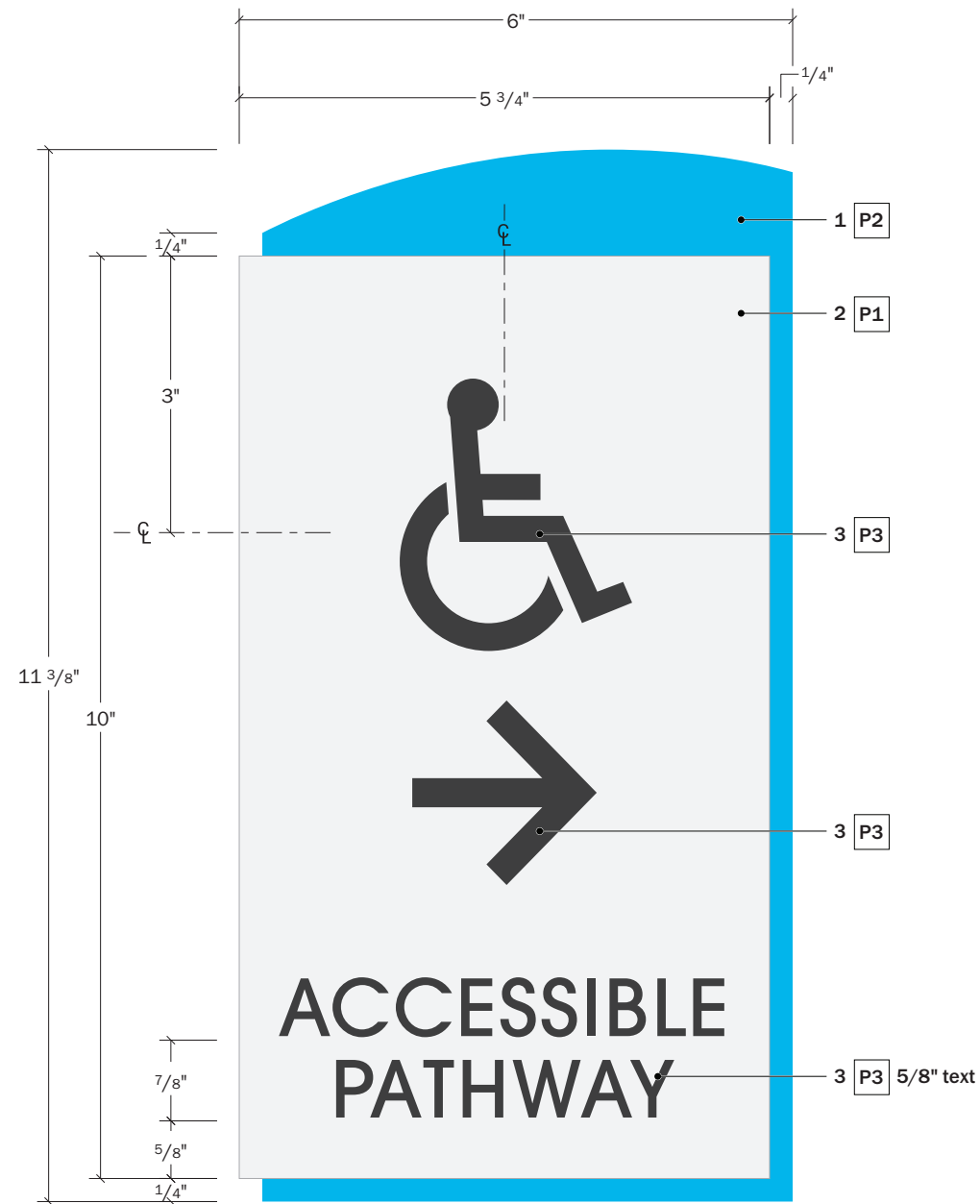
MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

**SIGN TYPE F5
CORRIDOR DIRECTIONAL
(SMALL)**

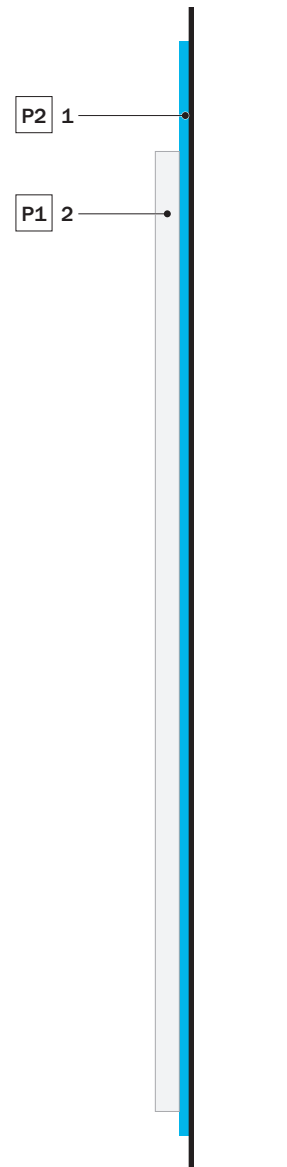
All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

DRAWING NOTES

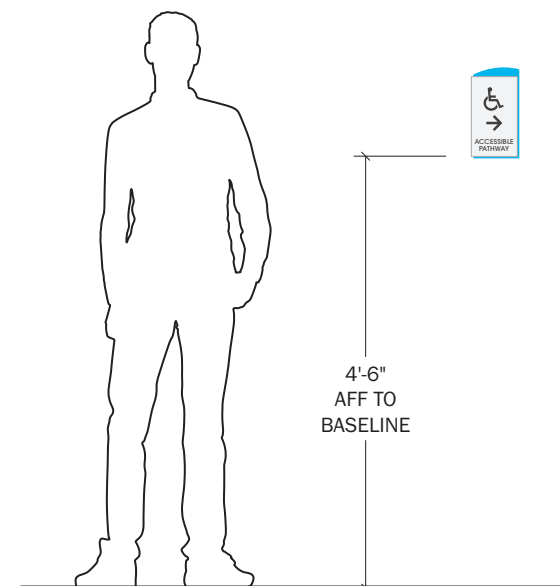
- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 1/4" Thick, acrylic sign panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive.
 - 3 Silk-screened copy and symbol on sign panel.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.



FRONT VIEW
SCALE: Half Size



SIDE VIEW
SCALE: Half Size



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE F6
ACCESSIBLE DIRECTIONAL
(WALL MOUNT)**

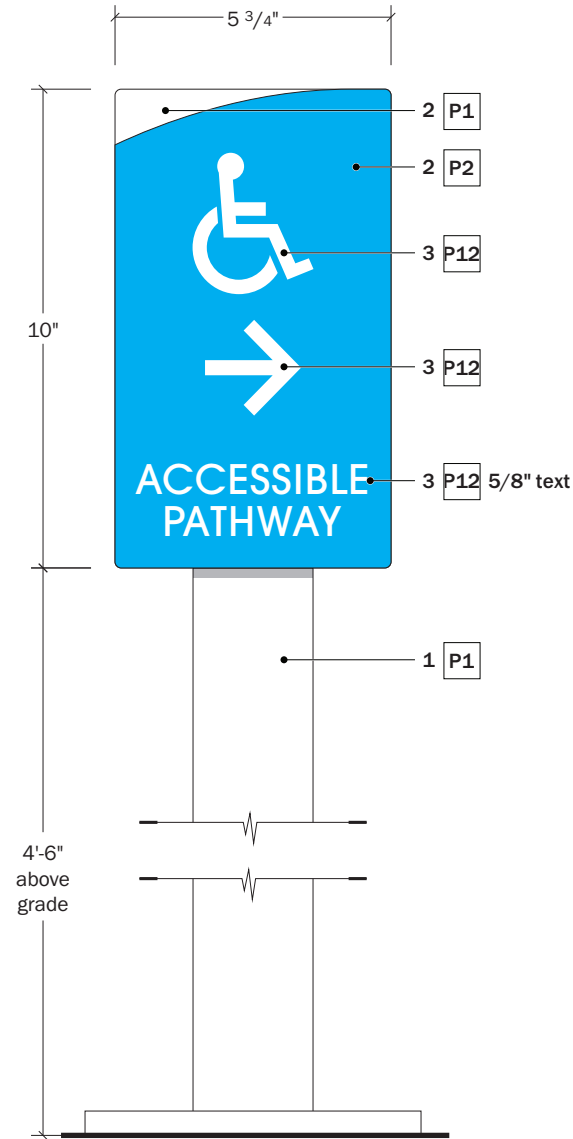
**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**

Oceanside, CA

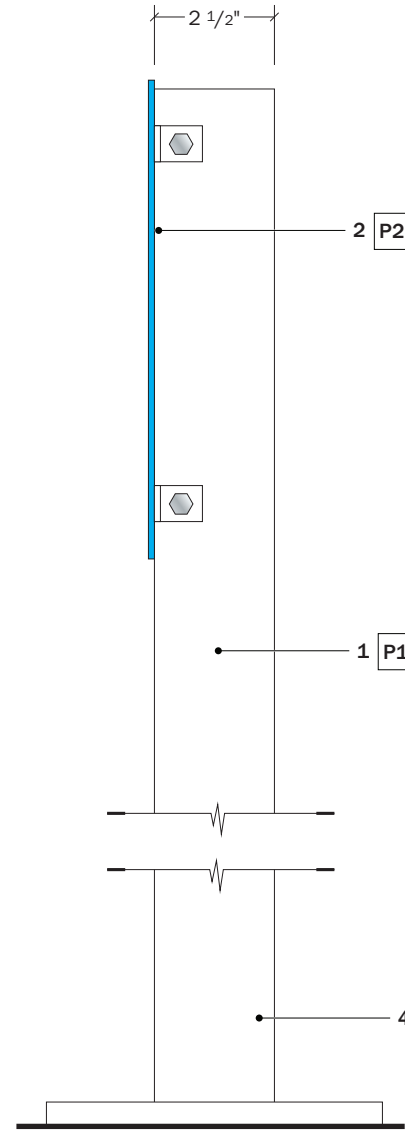
75-22602-00

July 18, 2023

Preliminary Signage Standards Manual



FRONT VIEW
SCALE: 3" = 1'- 0"



SIDE VIEW

- 1 2 1/2" square aluminum post w/ paint finish on all sides. Post is capped at top. Post is secured into concrete footing.
 - 2 1/8" thick aluminum sign panel w/ masked and painted graphic. Returns and backside are painted (P1). Sign panel is secured to post with mechanical fasteners via metal angles welded to back of panel. Angles are painted to match sign and post. Welds to be ground smooth and made neat.
 - 3 Masked and painted text and symbols on sign face.
 - 4 Concrete footing with depth below grade as required to maintain stability. Footing has exposed portion above grade to serve as mow-strip. Exposed portions of footing to be finished smoothly w/ neat corners and edges. If footing is located at a grade change, footing to extend below grade as required to maintain stability and above grade as needed to preserve desired height above grade.
- A Sign to be mounted plumb and level.
- B Sign fabricator to conduct site survey to inspect and confirm each sign location prior to fabrication and installation. Fabricator/installer responsible for surveying for buried utilities prior to installation.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE F7
ACCESSIBLE DIRECTIONAL
(POST MOUNT)**

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**

Oceanside, CA

75-22602-00

July 18, 2023

Preliminary Signage Standards Manual

DRAWING NOTES

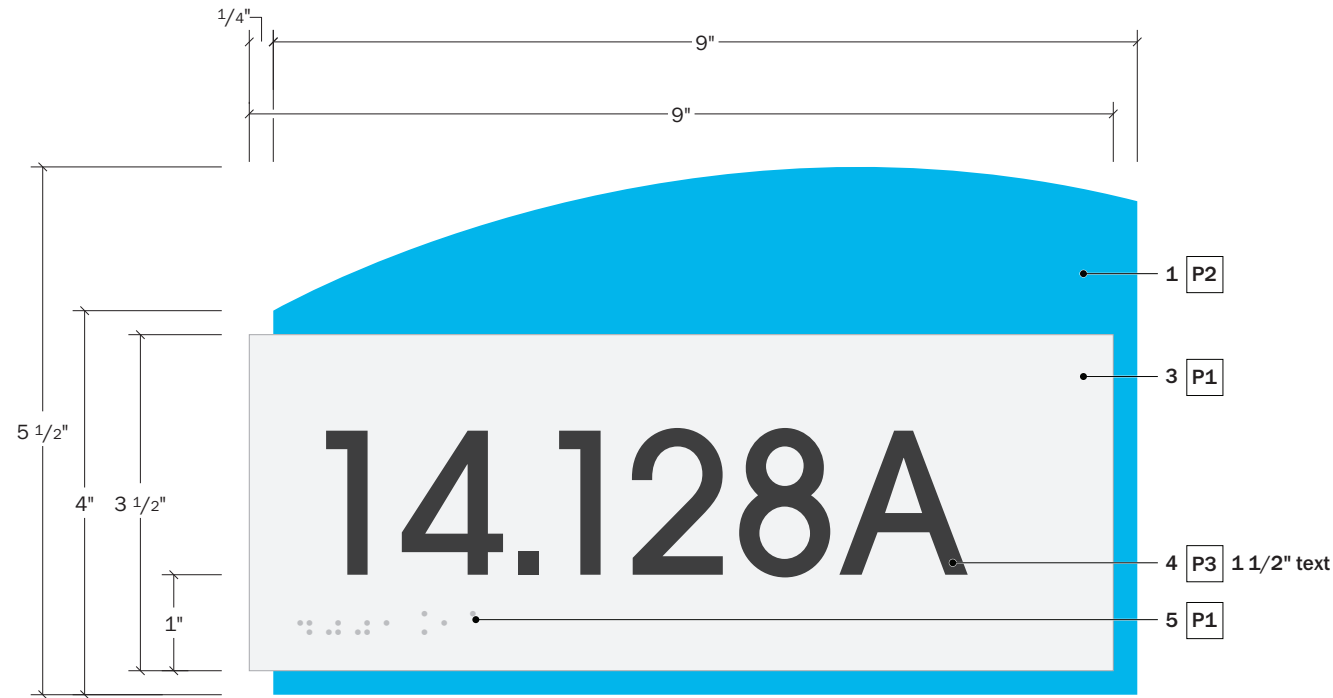
- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, acrylic core panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive.
 - 3 1/16" Thick, photopolymer face panel with paint finish on all sides. Panel has integrated raised lettering and braille. Panel is secured to core panel with full coverage, low-profile adhesive as required to prevent detachment.
 - 4 1/32" raised lettering per ADA guidelines. Lettering is integrated into photopolymer face panel. Lettering has silk-screened finish.
 - 5 Grade II braille integrated into photopolymer face panel. Braille to ADA guidelines. Translations by sign fabricator.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).
- C This sign is intended for interior use only.

**THIS SIGN TYPE AND SEVERAL OTHERS
IN THE FOLLOWING STANDARDS MANUAL
UTILIZE A NEW BUILDING AND ROOM
NUMBERING SYSTEM TO BE IMPLEMENTED
BY THE COLLEGE AT A FUTURE DATE.**

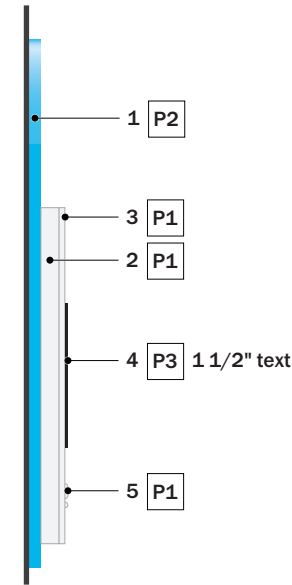
**IF SIGNS ARE INSTALLED PRIOR TO
NUMBERING SYSTEM IMPLEMENTATION,
BUILDING AND ROOM NUMBERS SHOULD BE
UPDATED AND SIGNS REPLACED AS NEEDED
TO FIT INTO THE SYSTEM.**

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

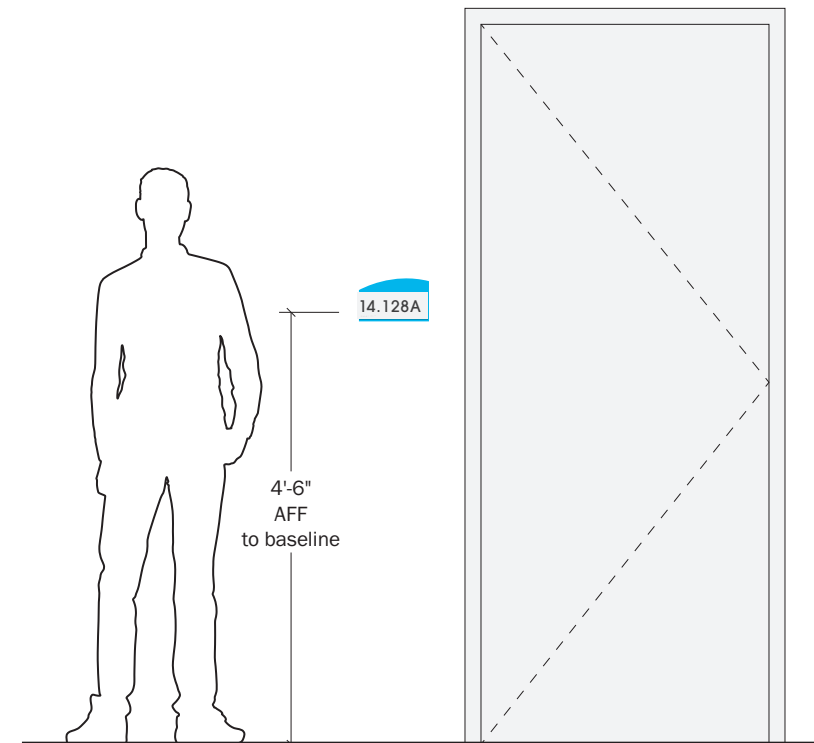
**SIGN TYPE G1
ADA ROOM NUMBER
IDENTIFICATION (INTERIOR)**



FRONT VIEW
SCALE: Half Size



SIDE VIEW



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**

Oceanside, CA

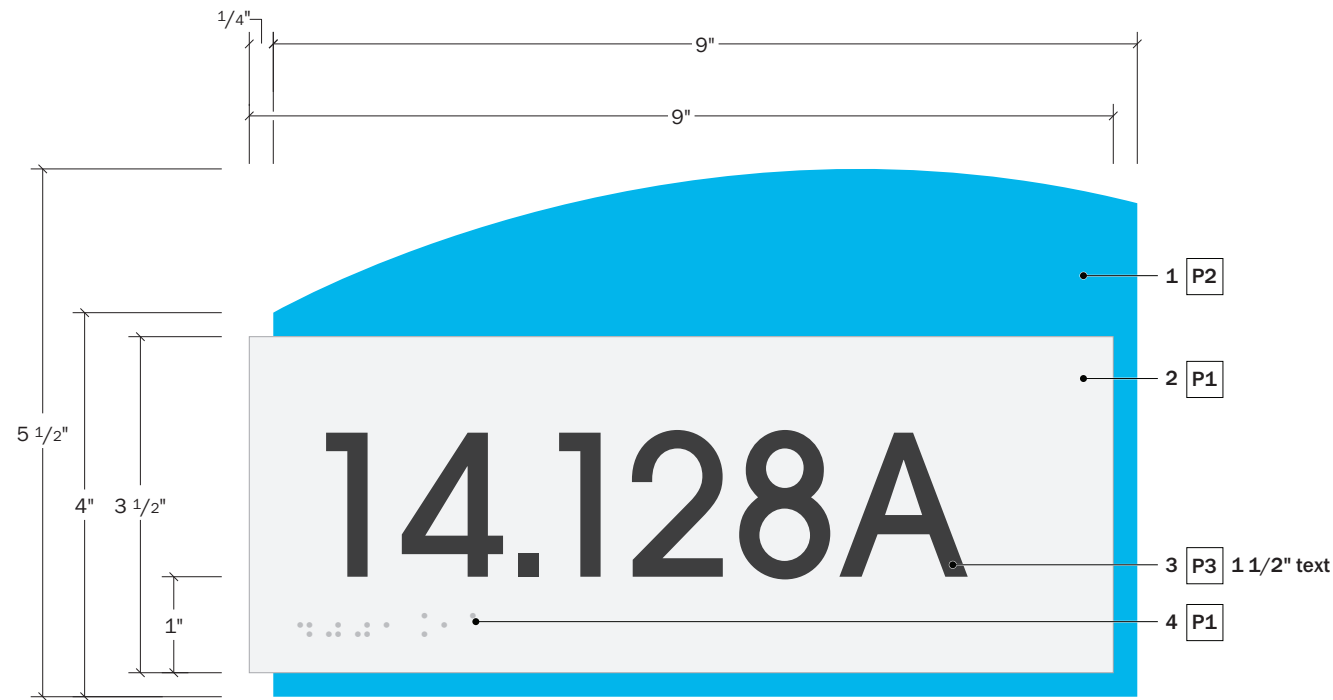
75-22602-00

July 18, 2023

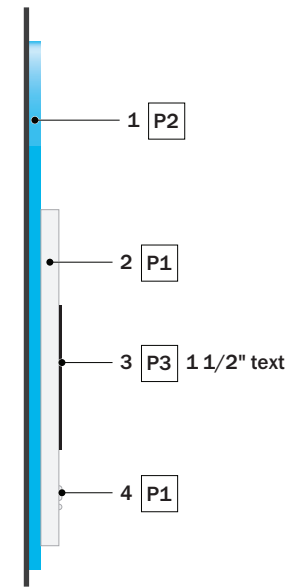
Preliminary Signage Standards Manual

DRAWING NOTES

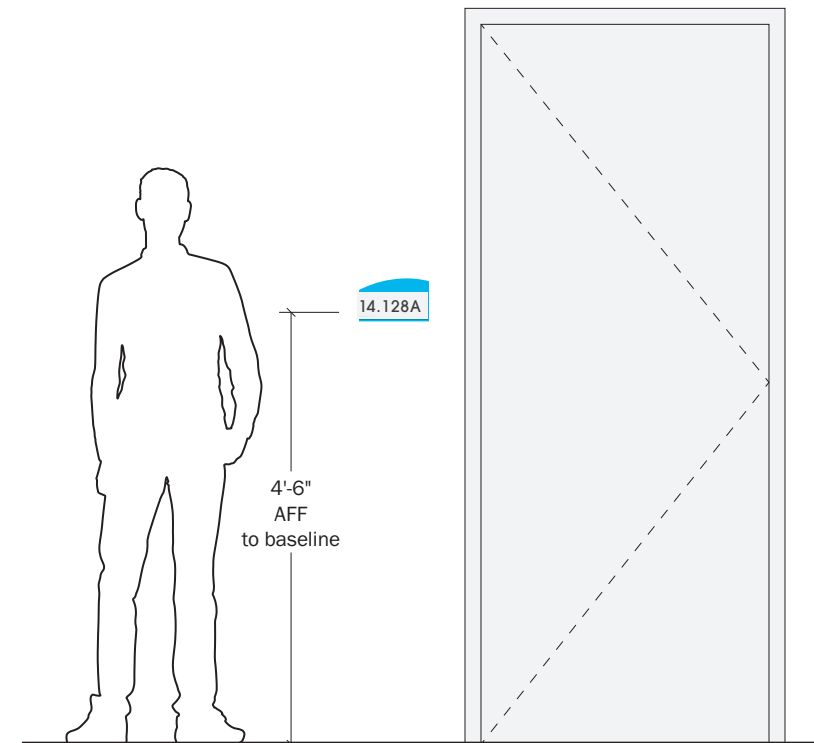
- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, chemically etched zinc sign panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive as required to prevent detachment. Sign panel has etched, raised lettering and braille.
 - 3 1/32" raised lettering per ADA guidelines. Lettering is integrated into zinc face panel. Lettering has silk-screened finish.
 - 4 Grade II braille integrated into zinc face panel. Braille to ADA guidelines. Translations by sign fabricator.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).
- C This sign is intended for exterior use.



FRONT VIEW
SCALE: Half Size



SIDE VIEW



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

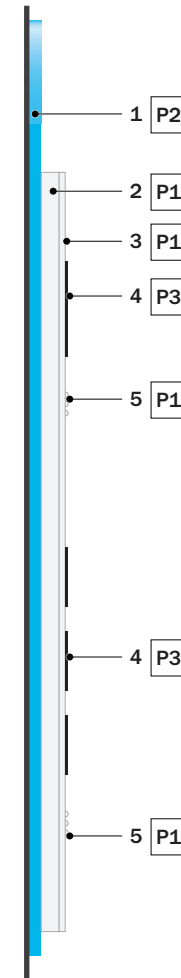
**SIGN TYPE G1.1
ADA ROOM NUMBER
IDENTIFICATION (EXTERIOR)**

DRAWING NOTES

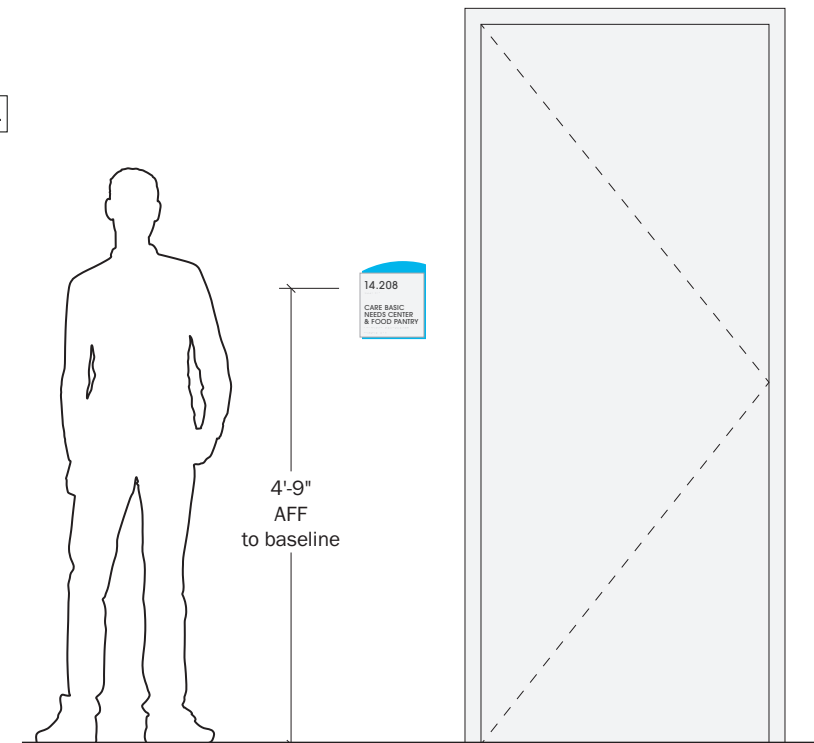
- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, acrylic core panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive.
 - 3 1/16" Thick, photopolymer face panel with paint finish on all sides. Panel has integrated raised lettering and braille. Panel is secured to core panel with full coverage, low-profile adhesive as required to prevent detachment.
 - 4 1/32" raised lettering per ADA guidelines. Lettering is integrated into photopolymer face panel. Lettering has silk-screened finish.
 - 5 Grade II braille integrated into photopolymer face panel. Braille to ADA guidelines. Translations by sign fabricator.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).
- C This sign is intended for interior use only.



FRONT VIEW - PERMANENT ROOM ID
SCALE: Half Size



SIDE VIEW



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE G2
ADA PERMANENT ROOM
IDENTIFICATION (INTERIOR)**

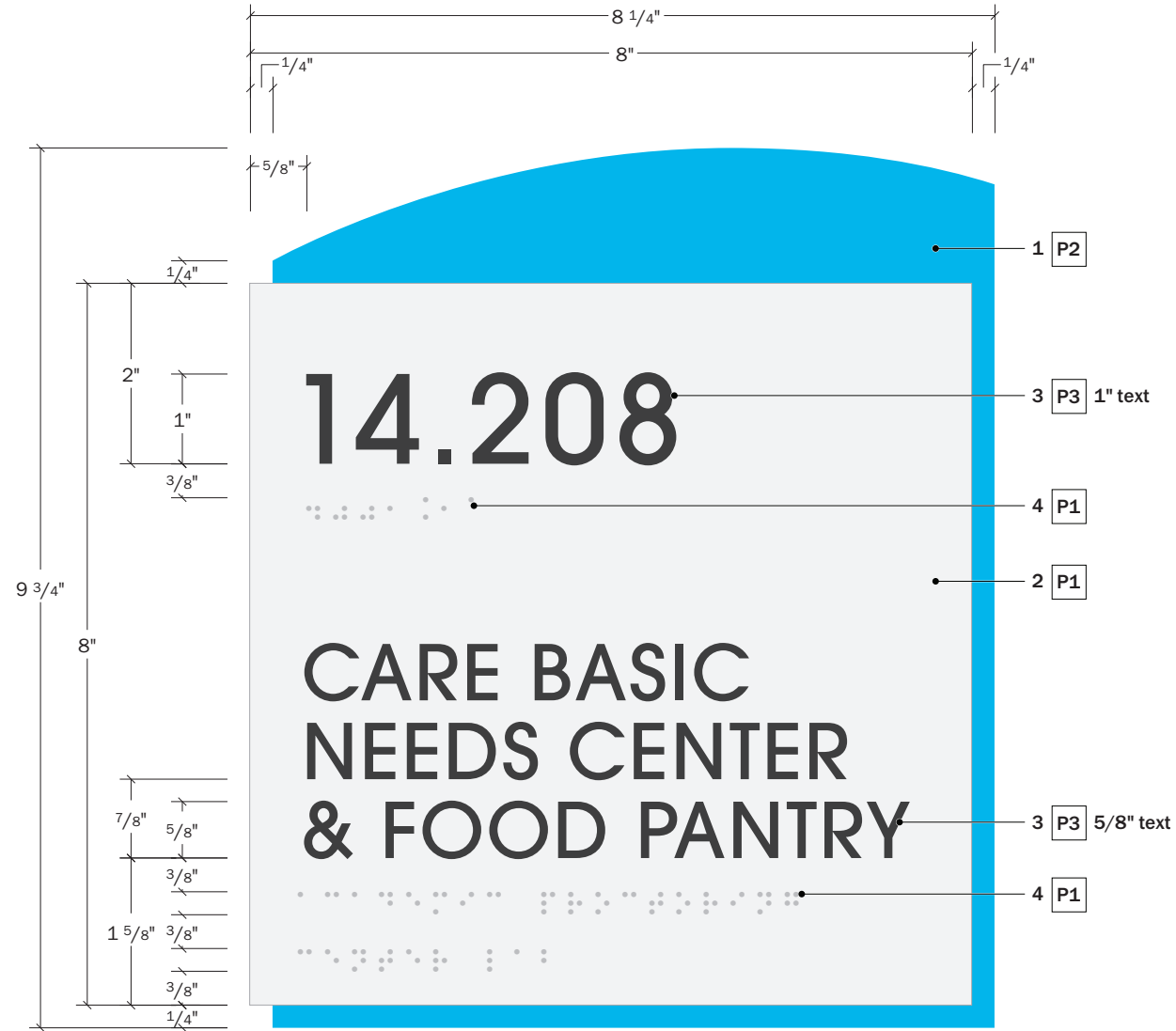
**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

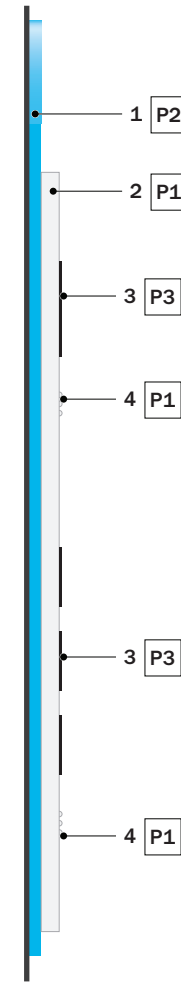
Preliminary Signage Standards Manual

DRAWING NOTES

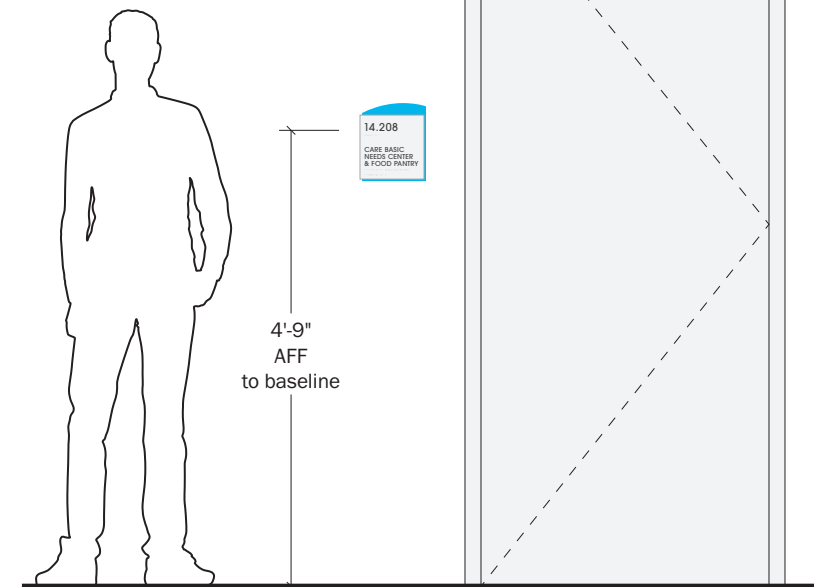
- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, chemically etched zinc sign panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive as required to prevent detachment. Sign panel has etched, raised lettering and braille.
 - 3 1/32" raised lettering per ADA guidelines. Lettering is integrated into zinc face panel. Lettering has silk-screened finish.
 - 4 Grade II braille integrated into zinc face panel. Braille to ADA guidelines. Translations by sign fabricator.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).
- C This sign is intended for exterior use.



FRONT VIEW - PERMANENT ROOM ID
SCALE: Half Size



SIDE VIEW



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE G2.1
ADA PERMANENT ROOM
IDENTIFICATION (EXTERIOR)**

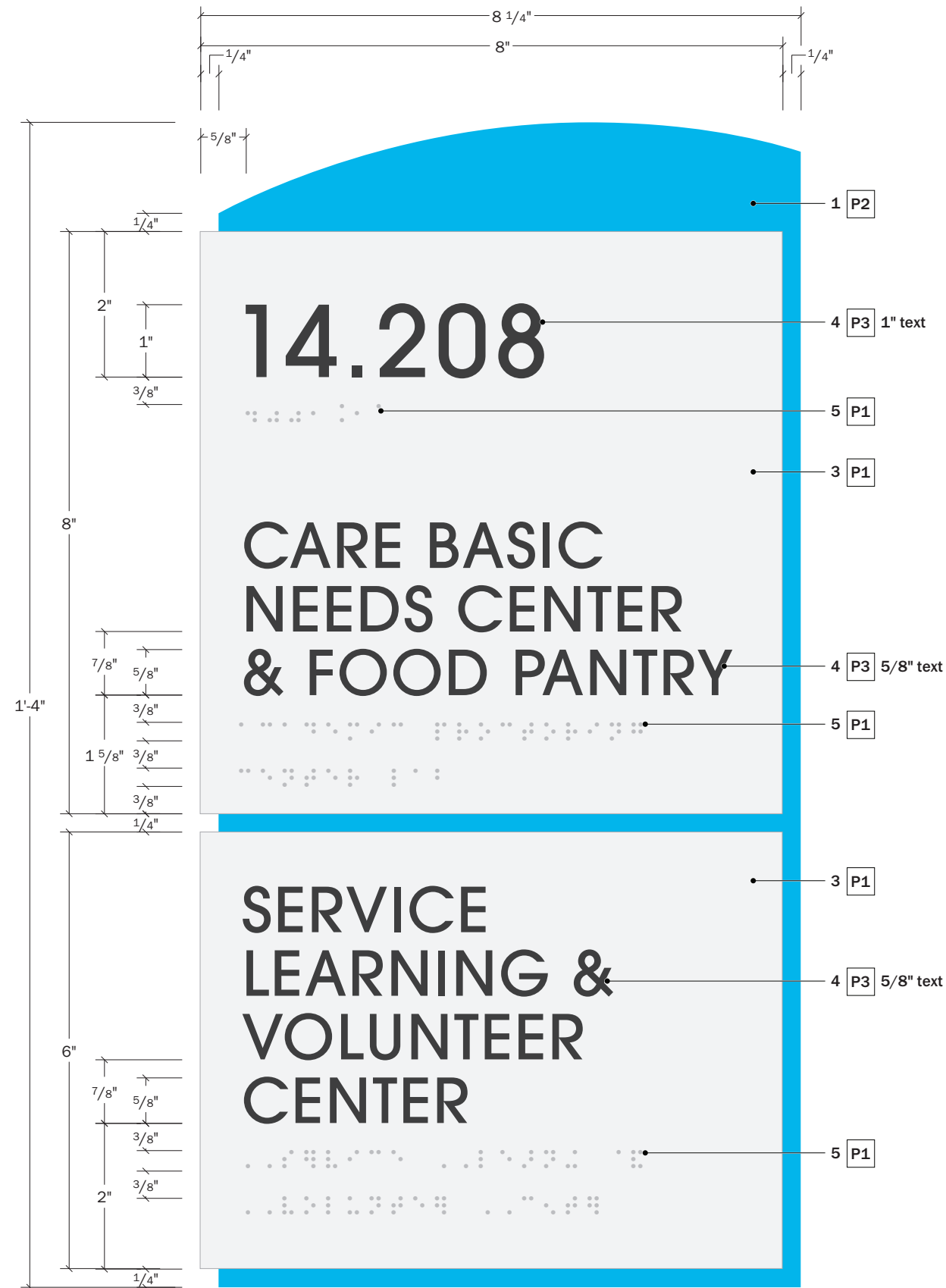
**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

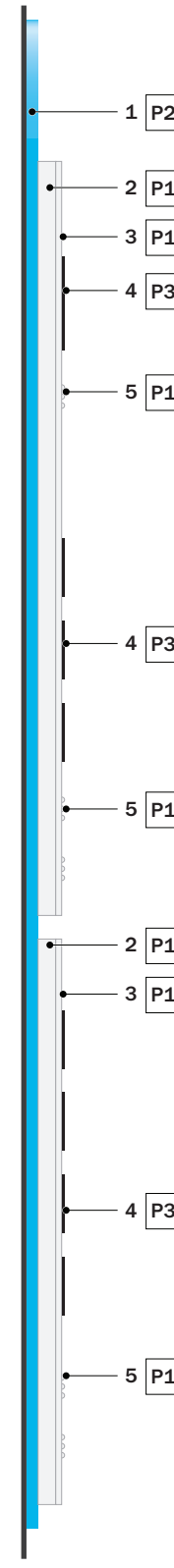
Preliminary Signage Standards Manual

DRAWING NOTES

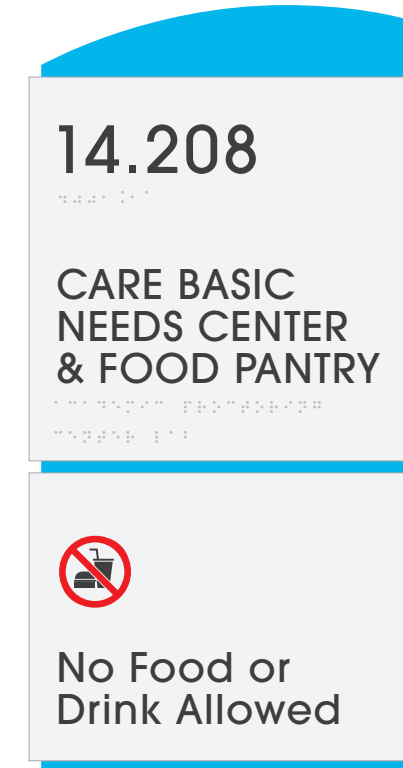
- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, acrylic core panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive.
 - 3 1/16" Thick, photopolymer face panel with paint finish on all sides. Panel has integrated raised lettering and braille. Panel is secured to core panel with full coverage, low-profile adhesive as required to prevent detachment.
 - 4 1/32" raised lettering per ADA guidelines. Lettering is integrated into photopolymer face panel. Lettering has silk-screened finish.
 - 5 Grade II braille integrated into photopolymer face panel. Braille to ADA guidelines. Translations by sign fabricator.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).
- C This sign is intended for interior use only.



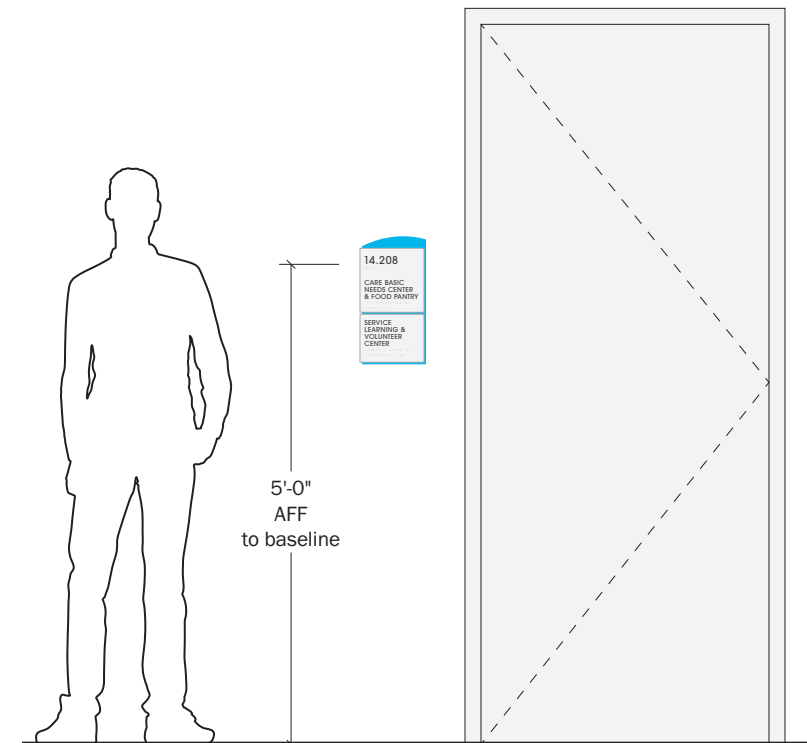
FRONT VIEW - PERMANENT ROOM ID
SCALE: Half Size



SIDE VIEW



ADDITIONAL LAYOUT OPTION
SCALE: 3" = 1'-0"



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

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**SIGN TYPE G2.2
ADA PERMANENT ROOM ID
LARGE (INTERIOR)**

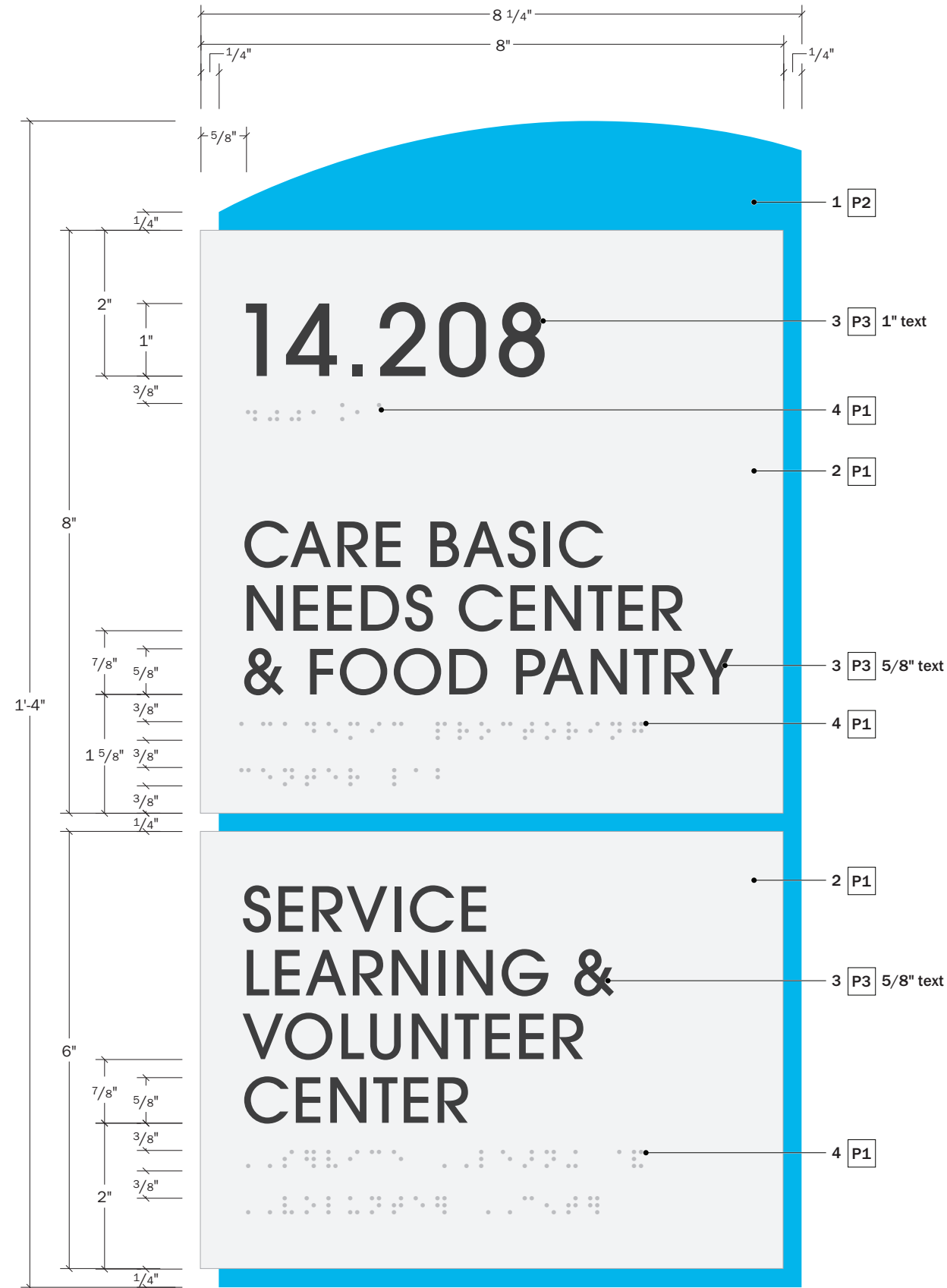
**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

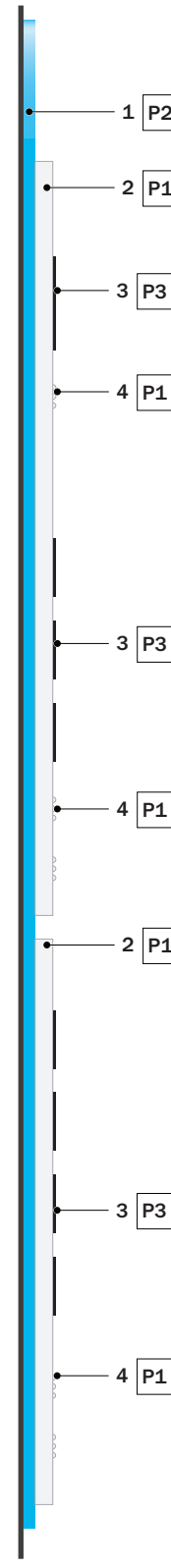
Preliminary Signage Standards Manual

DRAWING NOTES

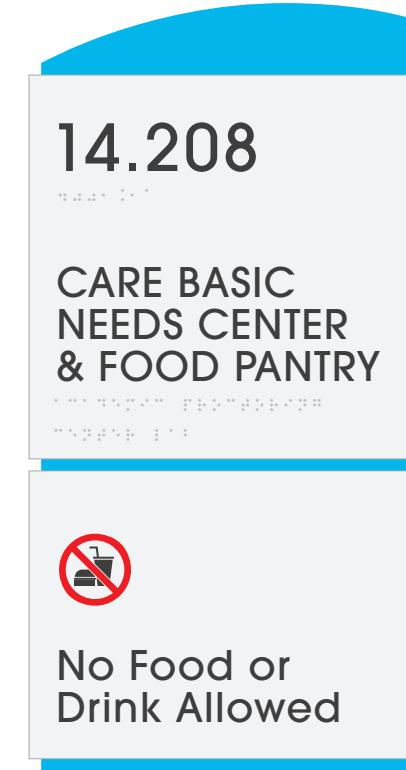
- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, chemically etched zinc sign panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive as required to prevent detachment. Sign panel has etched, raised lettering and braille.
 - 3 1/32" raised lettering per ADA guidelines. Lettering is integrated into zinc face panel. Lettering has silk-screened finish.
 - 4 Grade II braille integrated into zinc face panel. Braille to ADA guidelines. Translations by sign fabricator.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).
- C This sign is intended for exterior use.



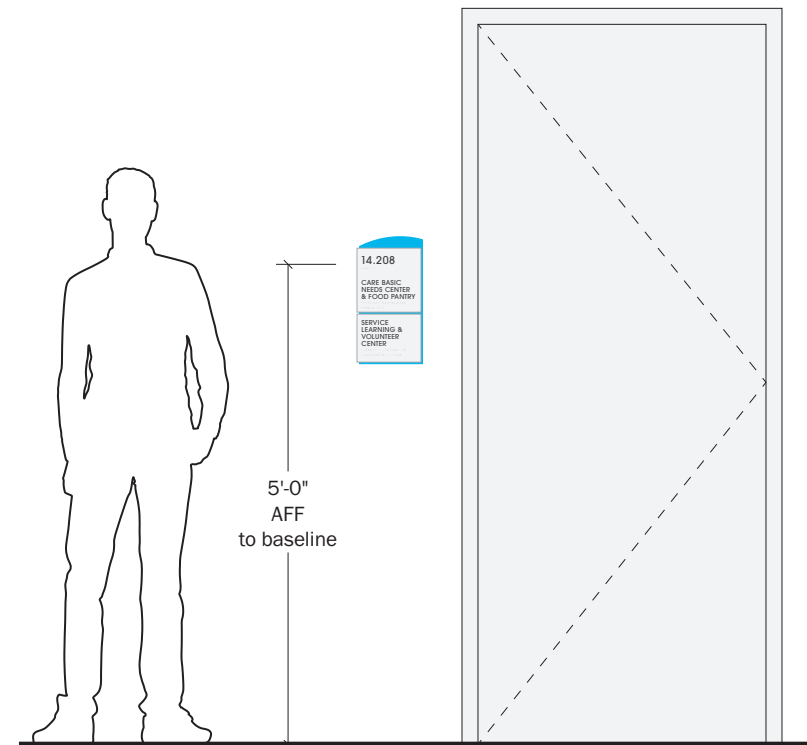
FRONT VIEW - PERMANENT ROOM ID
SCALE: Half Size



SIDE VIEW



ADDITIONAL LAYOUT OPTION
SCALE: 3" = 1'-0"



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE G2.3
ADA PERMANENT ROOM ID
LARGE (EXTERIOR)**

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

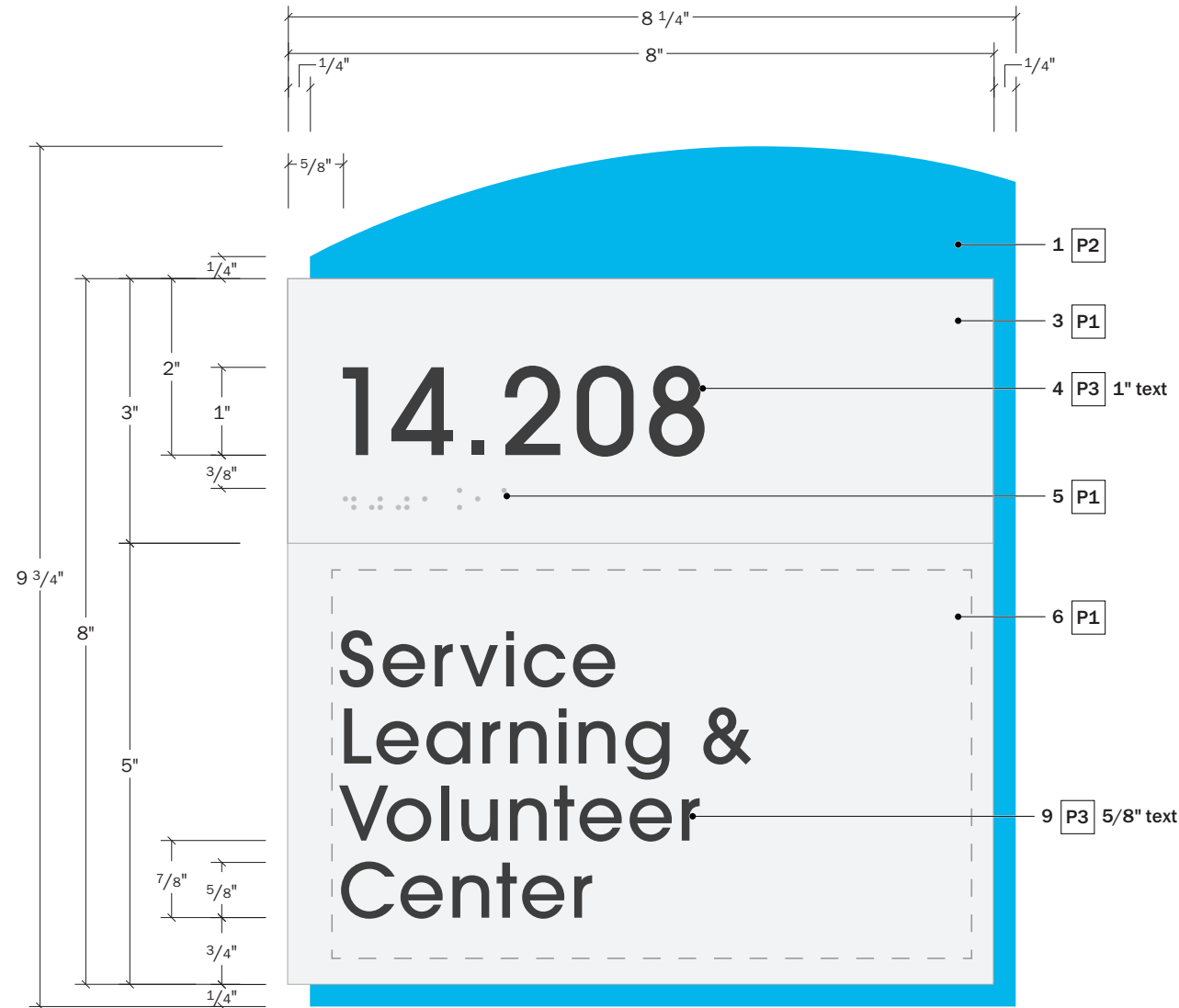
Preliminary Signage Standards Manual

DRAWING NOTES

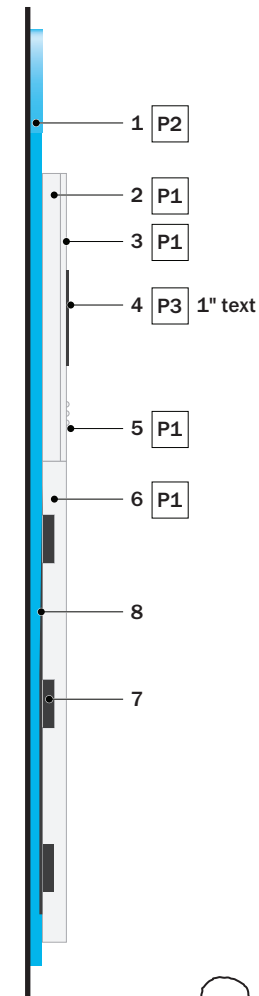
- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Panel to have routed pockets to host ferrous metal strips, adhered to panel — intent is to allow message panel (noted below) to stick to this area with magnets. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, acrylic core panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive.
 - 3 1/16" Thick, photopolymer face panel with paint finish on all sides. Panel has integrated raised lettering and braille. Panel is secured to core panel with full coverage, low-profile adhesive as required to prevent detachment.
 - 4 1/32" raised lettering per ADA guidelines. Lettering is integrated into photopolymer face panel. Lettering has silk-screened finish.
 - 5 Grade II braille integrated into photopolymer face panel. Braille to ADA guidelines. Translations by sign fabricator.
 - 6 1/4" Thick, acrylic message panel with routed pockets for magnetic strips to secure into. Message panel to be interchangeable with similar sign types. Magnets are attracted to ferrous metal strips embedded in backer panel.
 - 7 Thin, magnetic strip adhered to routed pocket of message panel. Magnets to be strong enough to support weight of acrylic panel.
 - 8 Thin, ferrous metal panel embedded into sign backer and secured with adhesive to prevent detachment.
 - 9 Silk-screened text on message panel.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).
- C Design intent is for interchangeable message panel to align flush with face of permanent photopolymer panel above. Panels to be cut square so they abut perfectly without significant gaps.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

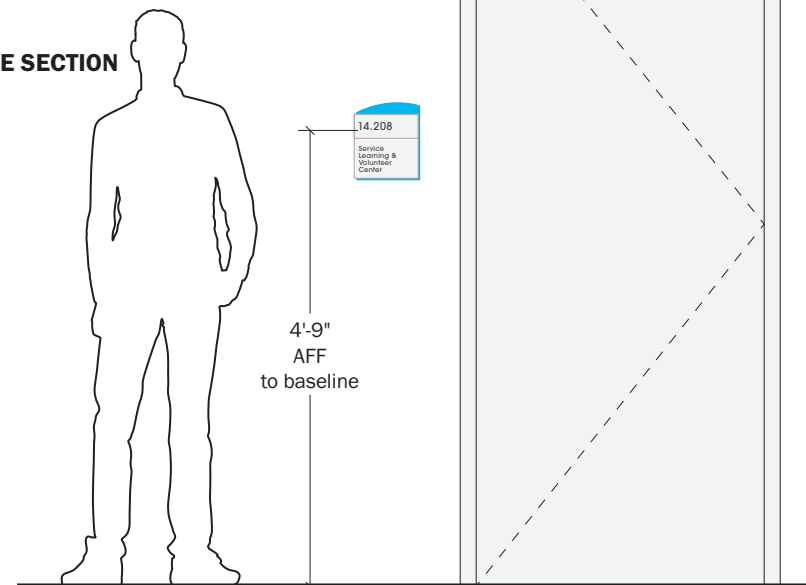
**SIGN TYPE G3
ADA ROOM IDENTIFICATION**



FRONT VIEW - PERMANENT ROOM ID
SCALE: Half Size



SIDE SECTION



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**

Oceanside, CA

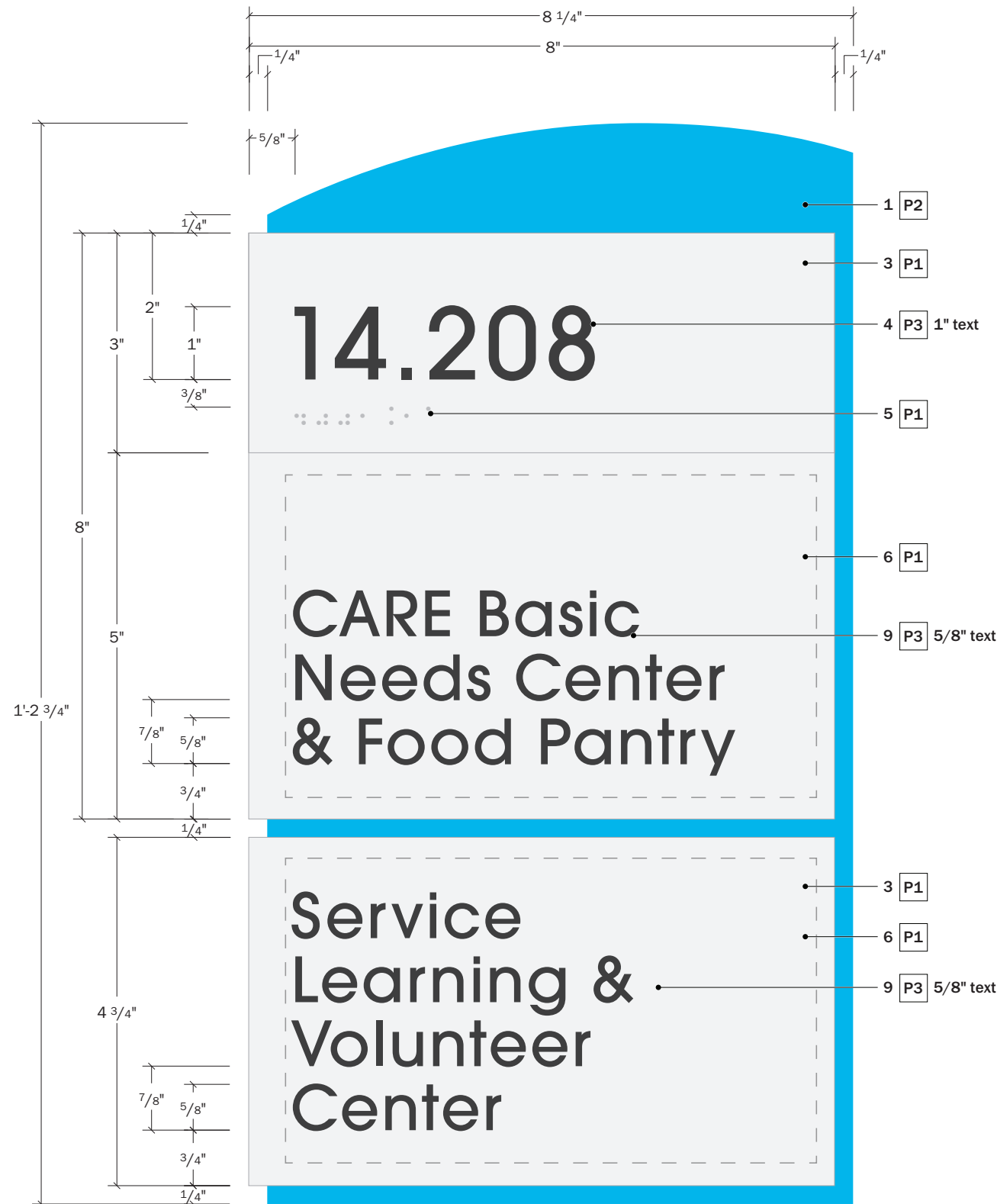
75-22602-00

July 18, 2023

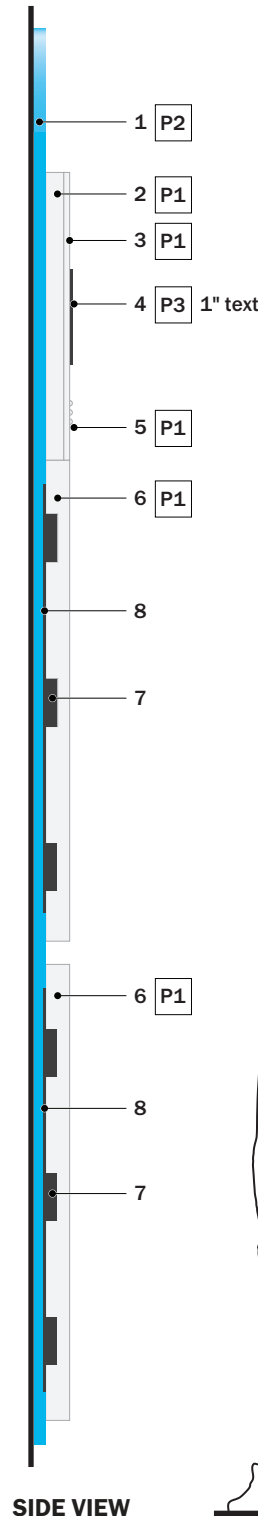
Preliminary Signage Standards Manual

DRAWING NOTES

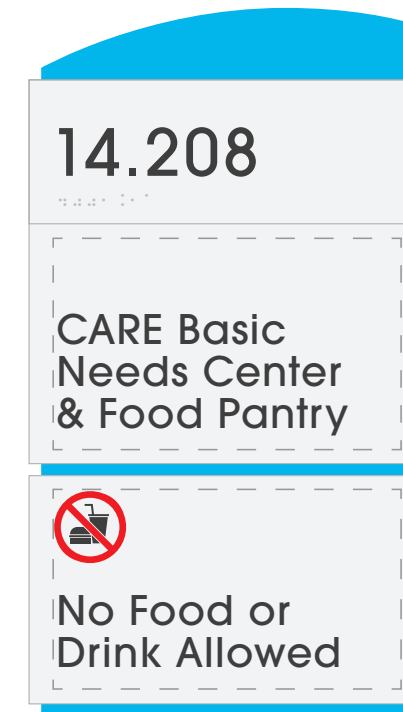
- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Panel to have routed pockets to host ferrous metal strips, adhered to panel — intent is to allow message panel (noted below) to stick to this area with magnets. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, acrylic core panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive.
 - 3 1/16" Thick, photopolymer face panel with paint finish on all sides. Panel has integrated raised lettering and braille. Panel is secured to core panel with full coverage, low-profile adhesive as required to prevent detachment.
 - 4 1/32" raised lettering per ADA guidelines. Lettering is integrated into photopolymer face panel. Lettering has silk-screened finish.
 - 5 Grade II braille integrated into photopolymer face panel. Braille to ADA guidelines. Translations by sign fabricator.
 - 6 1/4" Thick, acrylic message panel with routed pockets for magnetic strips to secure into. Message panel to be interchangeable with similar sign types. Magnets are attracted to ferrous metal strips embedded in backer panel.
 - 7 Thin, magnetic strip adhered to routed pocket of message panel. Magnets to be strong enough to support weight of acrylic panel.
 - 8 Thin, ferrous metal panel embedded into sign backer and secured with adhesive to prevent detachment.
 - 9 Silk-screened text on message panel.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).
- C Design intent is for interchangeable message panel to align flush with face of permanent photopolymer panel above. Panels to be cut square so they abut perfectly without significant gaps.



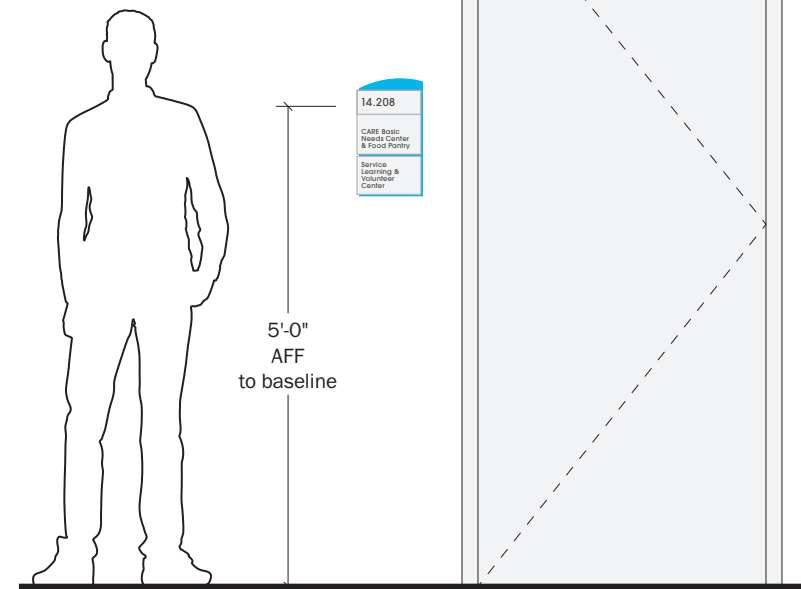
FRONT VIEW - PERMANENT ROOM ID
SCALE: Half Size



SIDE VIEW



ADDITIONAL LAYOUT OPTION
SCALE: 3" = 1'-0"



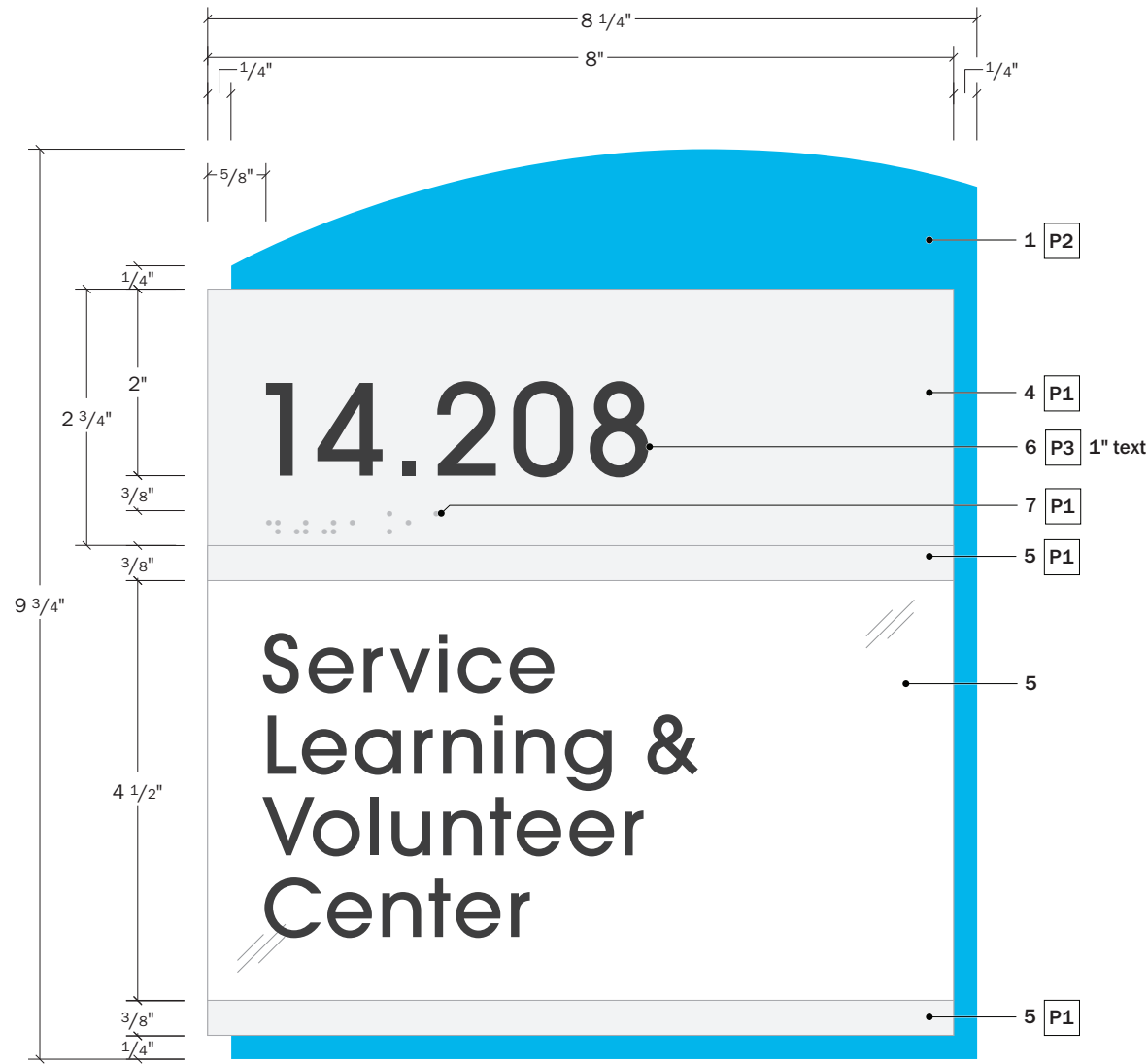
MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

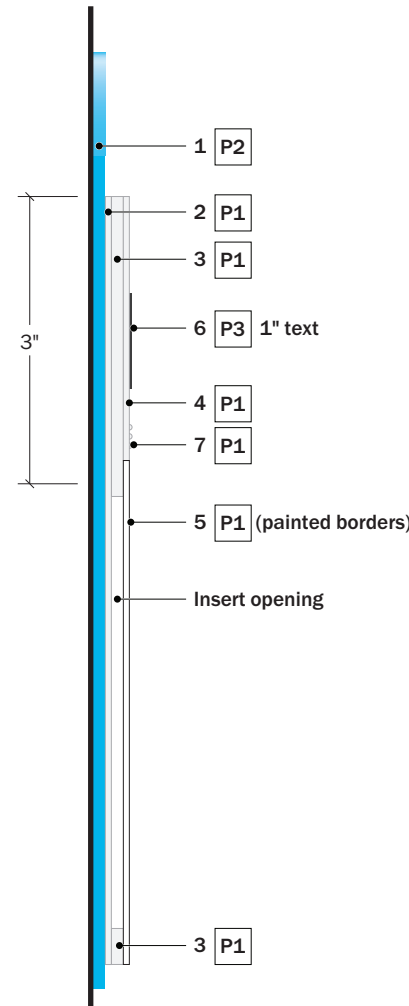
**SIGN TYPE G3.1
ADA ROOM IDENTIFICATION
LARGE**

DRAWING NOTES

- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 1/16" Thick, acrylic backer panel with paint finish on all sides. Panel is secured to backer panel (note 1 above) with full coverage, low-profile adhesive.
 - 3 1/8" Thick, acrylic spacer panel with paint finish on all sides. Panel is secured to backer panel (note 2 above) with full coverage, low-profile adhesive. Void is created between two pieces of the filler panel to create an insert window.
 - 4 1/16" Thick, photopolymer face panel with paint finish on all sides. Panel has integrated raised lettering and braille. Panel is secured to core panel with full coverage, low-profile adhesive as required to prevent detachment.
 - 5 1/16" Thick, clear acrylic window panel. Window panel is secured to filler panels with adhesive. Panel has painted border at top and bottom (first surface) to conceal adhesive.
 - 6 1/32" raised lettering per ADA guidelines. Lettering is integrated into photopolymer face panel. Lettering has silk-screened finish.
 - 7 Grade II braille integrated into photopolymer face panel. Braille to ADA guidelines. Translations by sign fabricator.
 - 8 Bright white paper insert with laser-jet print of room name. Sign fabricator to supply and install for each location upon. Refer to message schedule for messages for each location.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).
- C This sign is intended for interior use only.
- D Design intent is to create sign with paper insert window to display faculty info and other information.



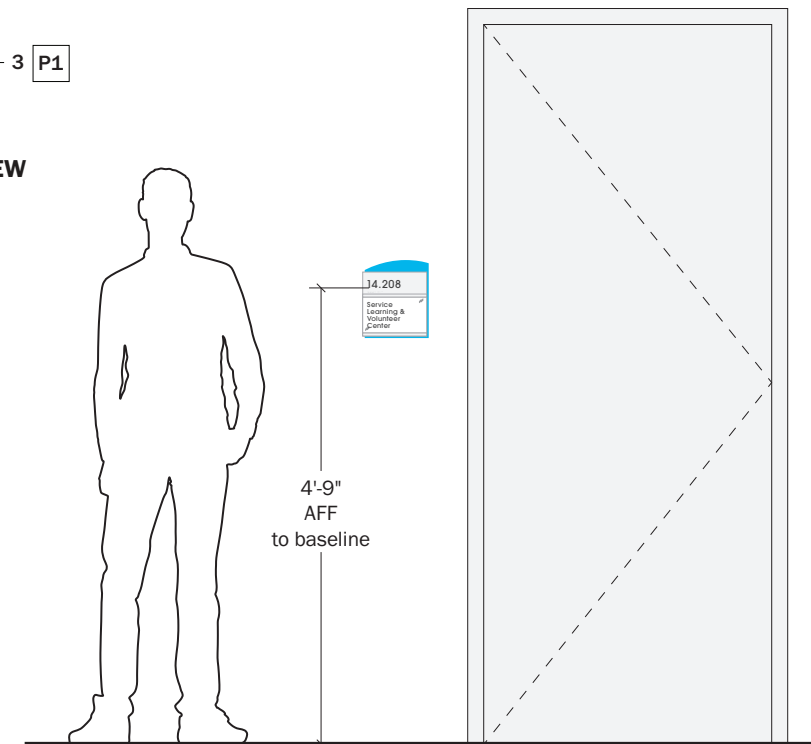
FRONT VIEW - (INSERT SHOWN IN PLACE)
SCALE: Half Size



SIDE VIEW



CHANGEABLE MESSAGE INSERT PANEL



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE G4
ADA ROOM IDENTIFICATION
W/ INSERT**

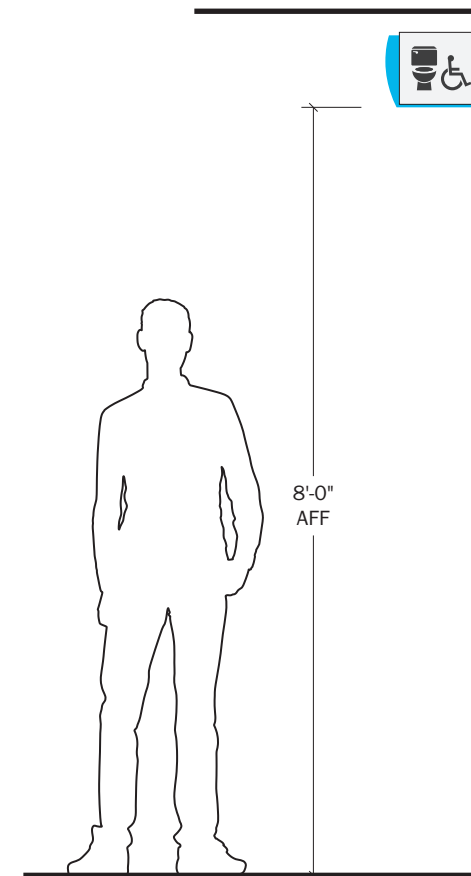
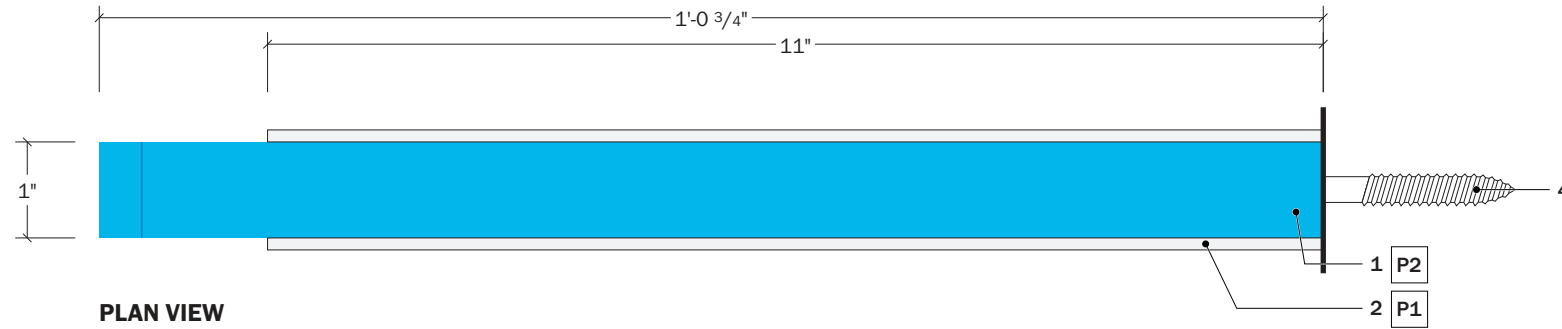
**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

Preliminary Signage Standards Manual

DRAWING NOTES

- 1 1" Thick fabricated sign core with paint finish on all sides. Sign core has curved edge as shown in drawing. Curve to be smooth with welds ground and finished. Sign core has concealed mounting attachment to wall. Sign fabricator to develop mounting for review in shop drawings. Mounting conditions may vary -- Sign fabricator to confirm all locations prior to shop drawings.
 - 2 1/8" Thick aluminum face panels with paint finish on all sides. Face panels are adhered to sign core with full coverage adhesive.
 - 3 Silk-screened symbol on face panel. Signs are double-sided. Refer to message schedule for sign message.
 - 4 Mounting hardware as required to secure sign to wall surface. Sign fabricator to field verify all locations prior to install to determine appropriate hardware. No exposed fasteners allowed.
- A Sign fabricator to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B Sign fabricator to confirm mounting heights are permitted with ceiling heights at each location prior to install.

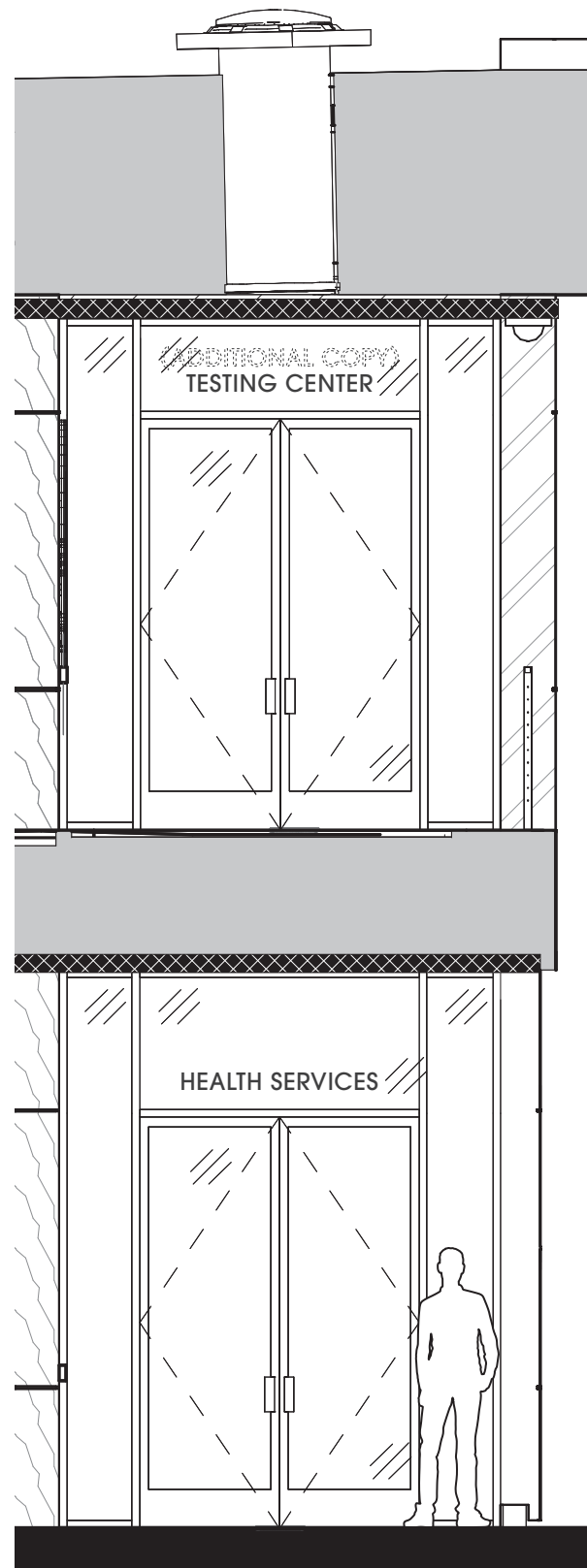


All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

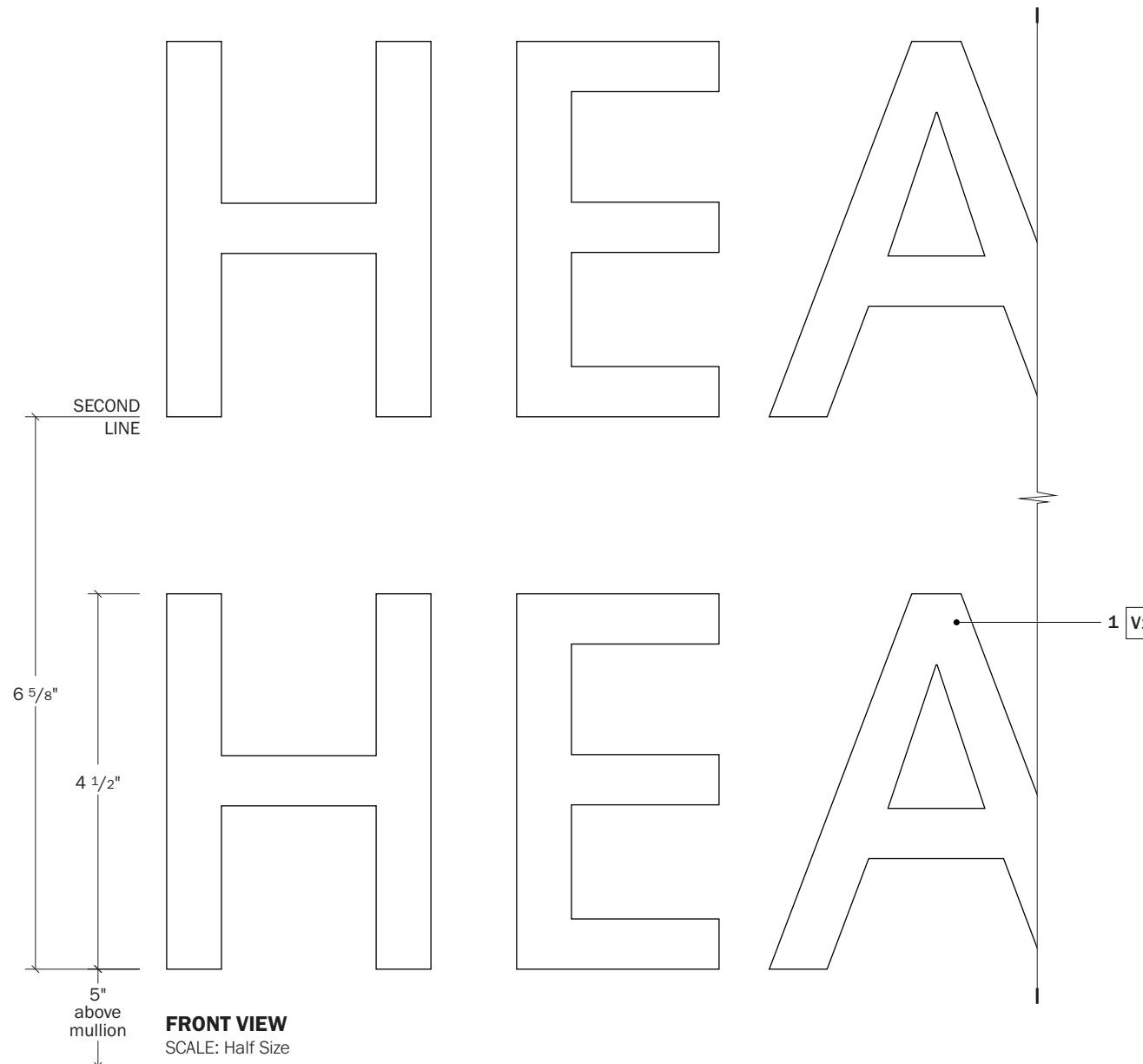
**SIGN TYPE G5
IDENTIFICATION BLADE**

DRAWING NOTES

- 1 Applied vinyl lettering on first surface of glass. Letters are applied level, and free of air bubbles, creases, folds and tears.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B Sign fabricator to confirm sign messages with Owner prior to shop drawings.



MOUNTING ELEVATION
SCALE: 1/4" = 1'-0"

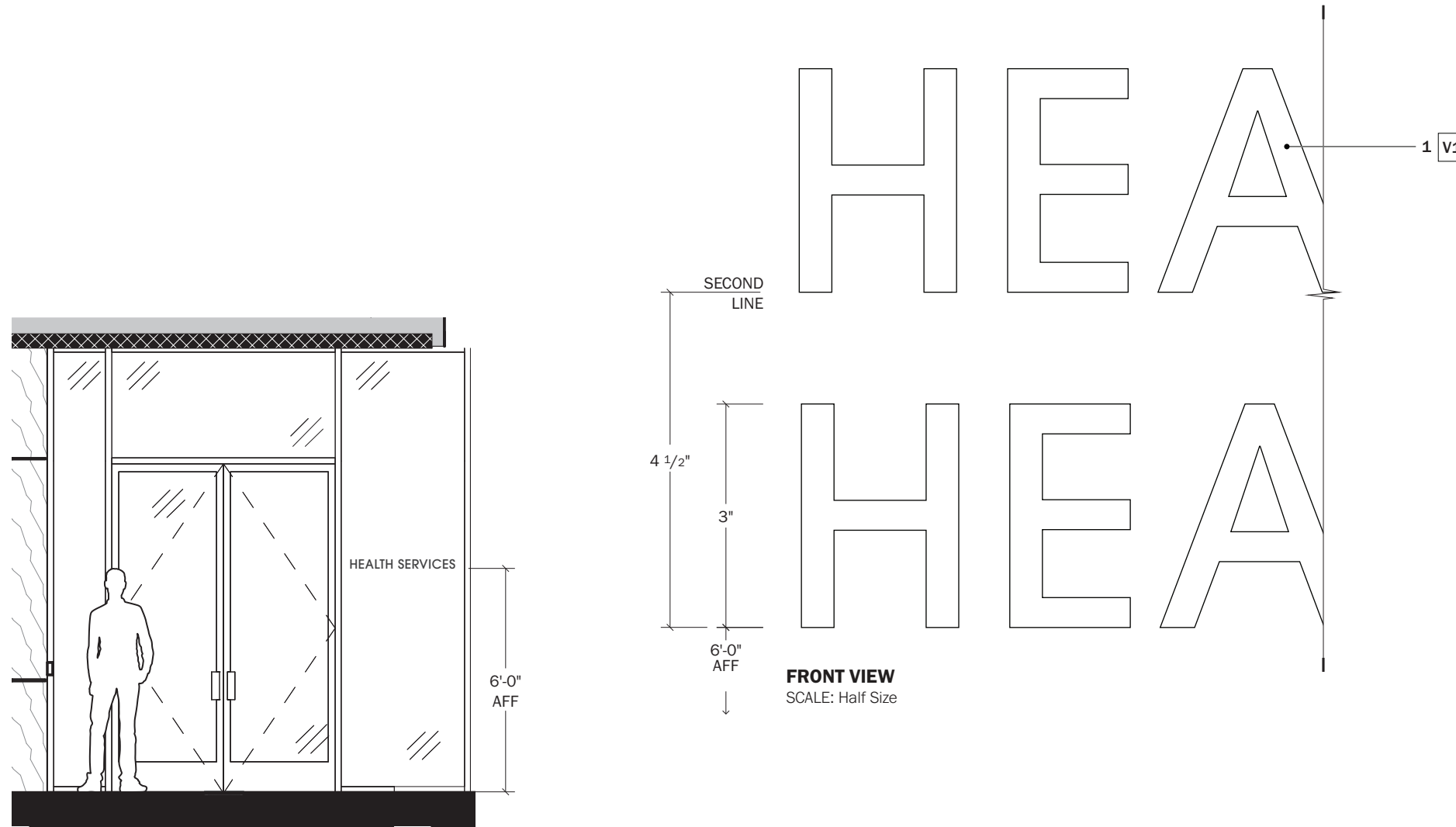


All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

SIGN TYPE G6
DEPARTMENT IDENTIFICATION
LARGE (GLASS)

DRAWING NOTES

- 1 Applied vinyl lettering on first surface of glass. Letters are applied level, and free of air bubbles, creases, folds and tears.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B Sign fabricator to confirm sign messages with Owner prior to shop drawings.



MOUNTING ELEVATION
SCALE: 1/4" = 1'-0"

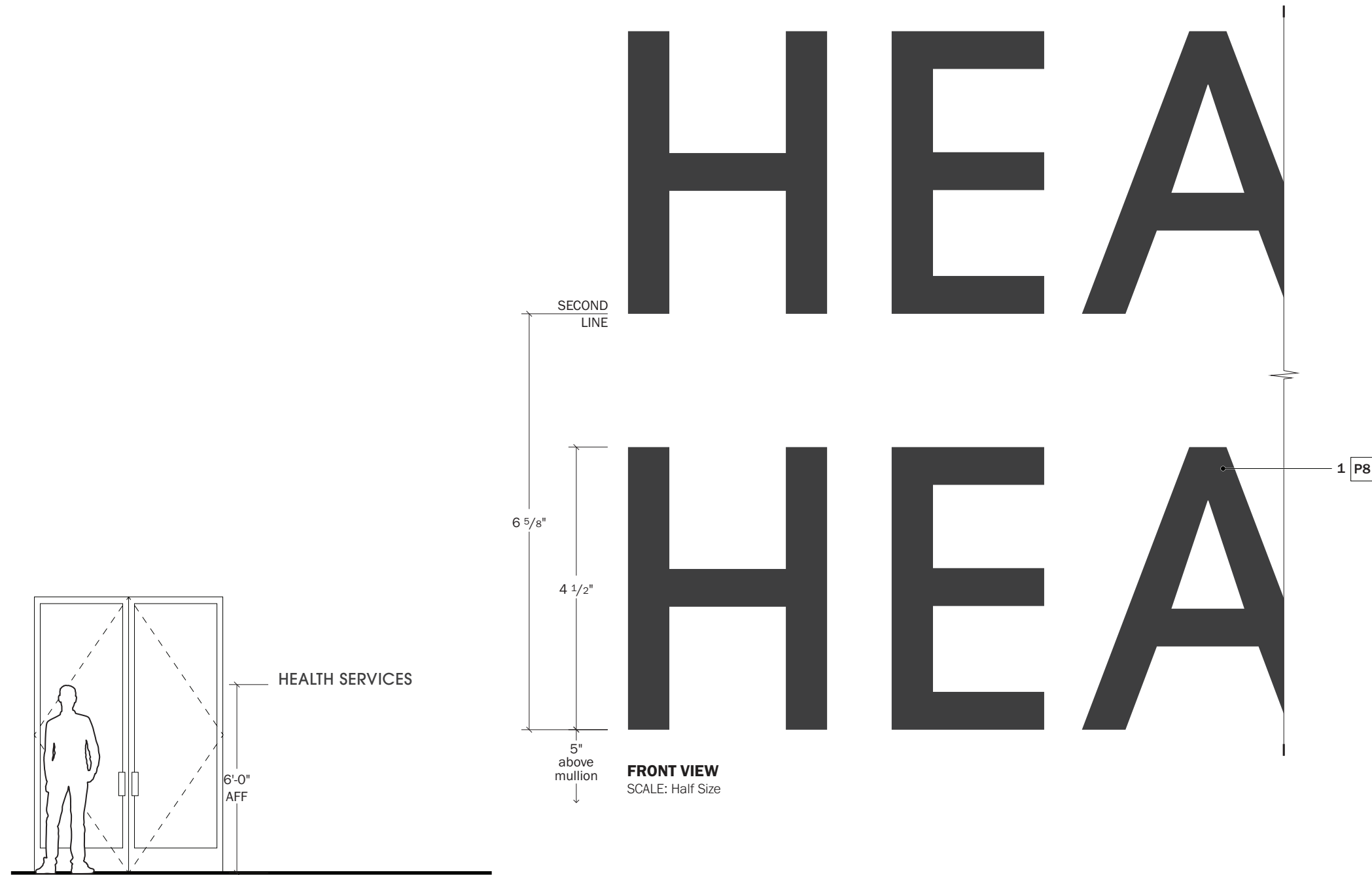
FRONT VIEW
SCALE: Half Size

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

SIGN TYPE G6.1
DEPARTMENT IDENTIFICATION
SMALL (GLASS)

DRAWING NOTES

- 1 3/8" thick, flat, cut-out aluminum letters with paint finish on all sides. Letters are flush mounted to wall surface with metal back-pins (minimum 3 pins per letter) and epoxy.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B Confirm wall surface will have adequate contrast with letters in color as noted. If wall is dark or in low light conditions, consider using a white or silver paint color from the brand assets page in this document as an alternate.



MOUNTING ELEVATION
SCALE: 1/4" = 1'-0"

FRONT VIEW
SCALE: Half Size

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

SIGN TYPE G7
DEPARTMENT IDENTIFICATION
LARGE (WALL)

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**

Oceanside, CA

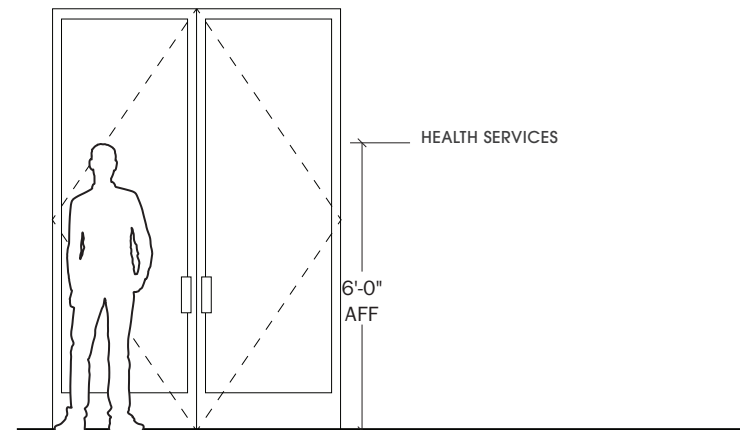
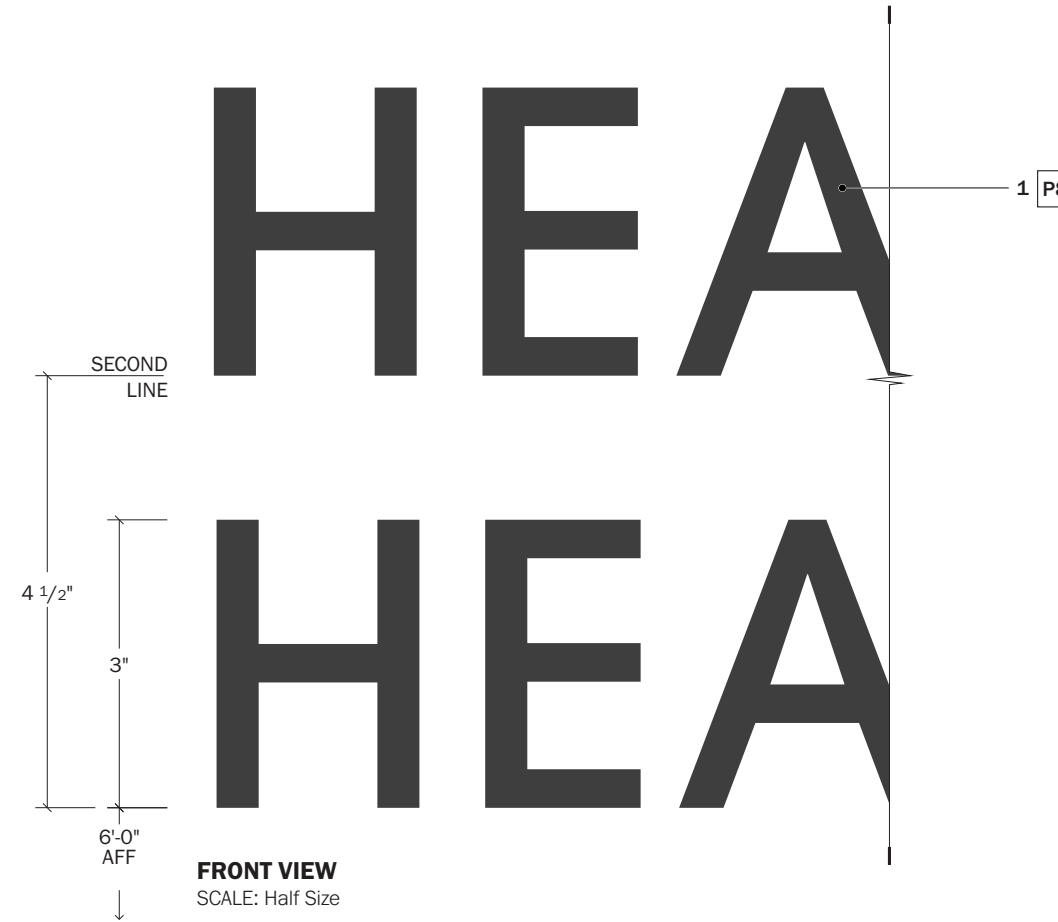
75-22602-00

July 18, 2023

Preliminary Signage Standards Manual

DRAWING NOTES

- 1 1/4" thick, flat, cut-out aluminum letters with paint finish on all sides. Letters are flush mounted to wall surface with metal back-pins (minimum 3 pins per letter) and epoxy.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B Confirm wall surface will have adequate contrast with letters in color as noted. If wall is dark or in low light conditions, consider using a white or silver paint color from the brand assets page in this document as an alternate.
- C This sign type can be paired with sign type G7 if needed to indicate a hierarchy of information.



MOUNTING ELEVATION
SCALE: 1/4" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE G7.1
DEPARTMENT IDENTIFICATION
SMALL (WALL)**

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

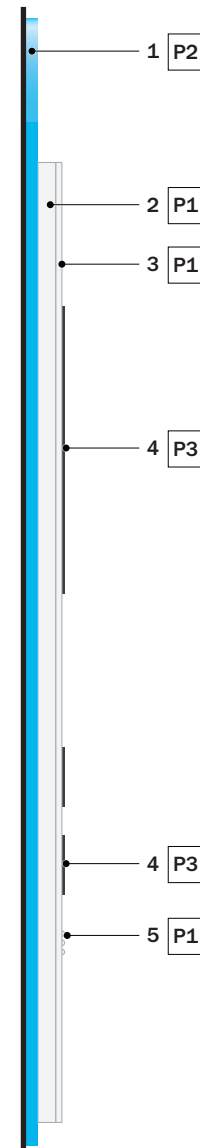
Preliminary Signage Standards Manual

DRAWING NOTES

- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, acrylic core panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive.
 - 3 1/16" Thick, photopolymer face panel with paint finish on all sides. Panel has integrated raised lettering and braille. Panel is secured to core panel with full coverage, low-profile adhesive as required to prevent detachment.
 - 4 1/32" raised lettering and symbol per ADA guidelines. Lettering is integrated into photopolymer face panel. Lettering has silk-screened finish.
 - 5 Grade II braille integrated into photopolymer face panel. Braille to ADA guidelines. Translations by sign fabricator.
 - 6 Silk-screened room number on photopolymer panel. These letters are not raised and do not require braille.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1. above).
- C This sign is intended for interior use only.



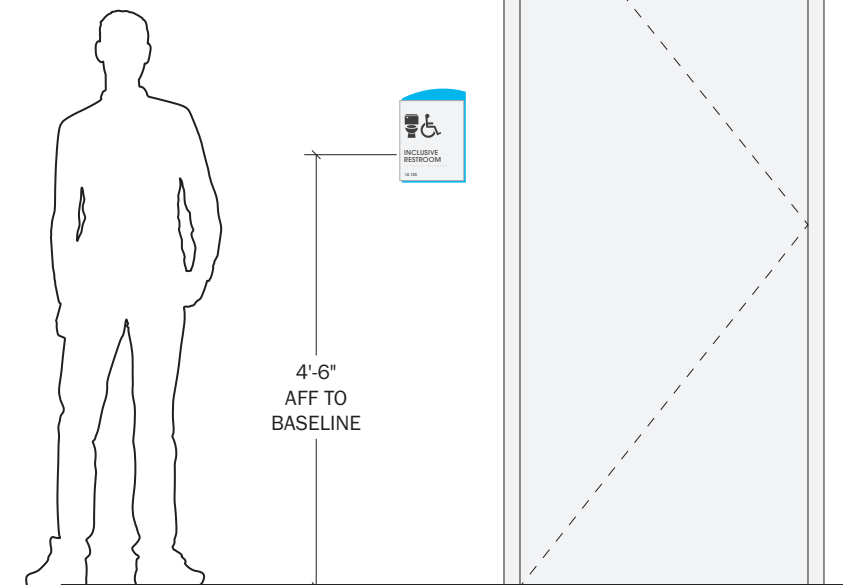
FRONT VIEW
SCALE: Half Size



SIDE VIEW



ADDITIONAL LAYOUTS
SCALE: 3"=1'-0"



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE H1
RESTROOM IDENTIFICATION
(INTERIOR)**

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

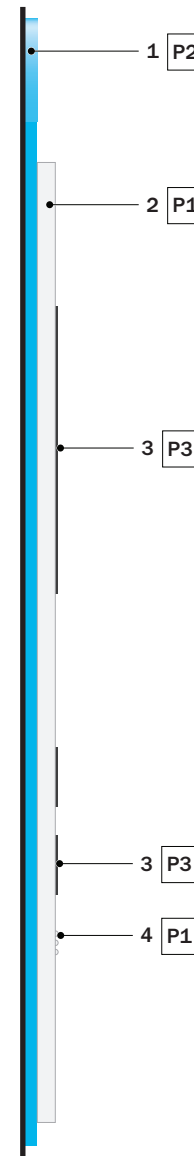
Preliminary Signage Standards Manual

DRAWING NOTES

- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, chemically etched zinc sign panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive as required to prevent detachment. Sign panel has etched, raised lettering and braille.
 - 3 1/32" raised lettering and symbol per ADA guidelines. Lettering is integrated into zinc face panel. Lettering has silk-screened finish.
 - 4 Grade II braille integrated into zinc face panel. Braille to ADA guidelines. Translations by sign fabricator.
 - 5 Silk-screened room number on photopolymer panel. These letters are not raised and do not require braille.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).
- C This sign is intended for exterior use.



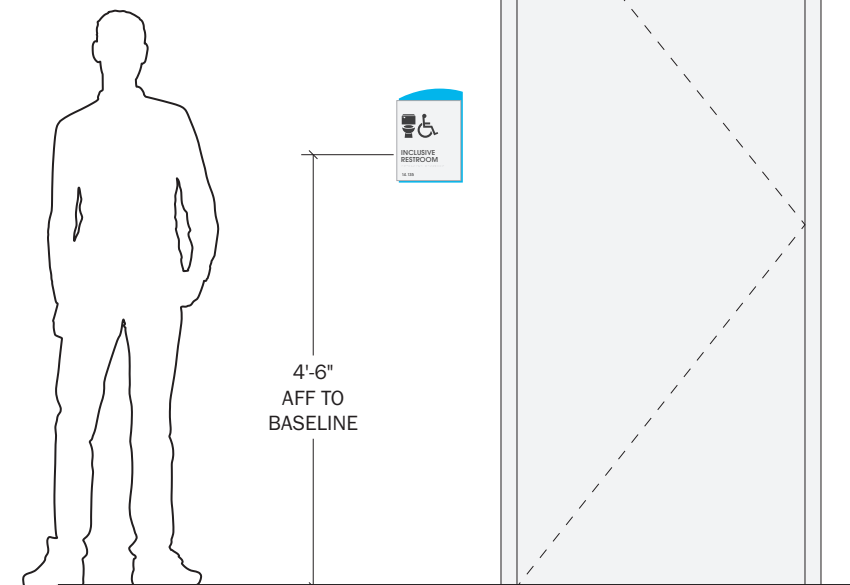
FRONT VIEW
SCALE: Half Size



SIDE VIEW



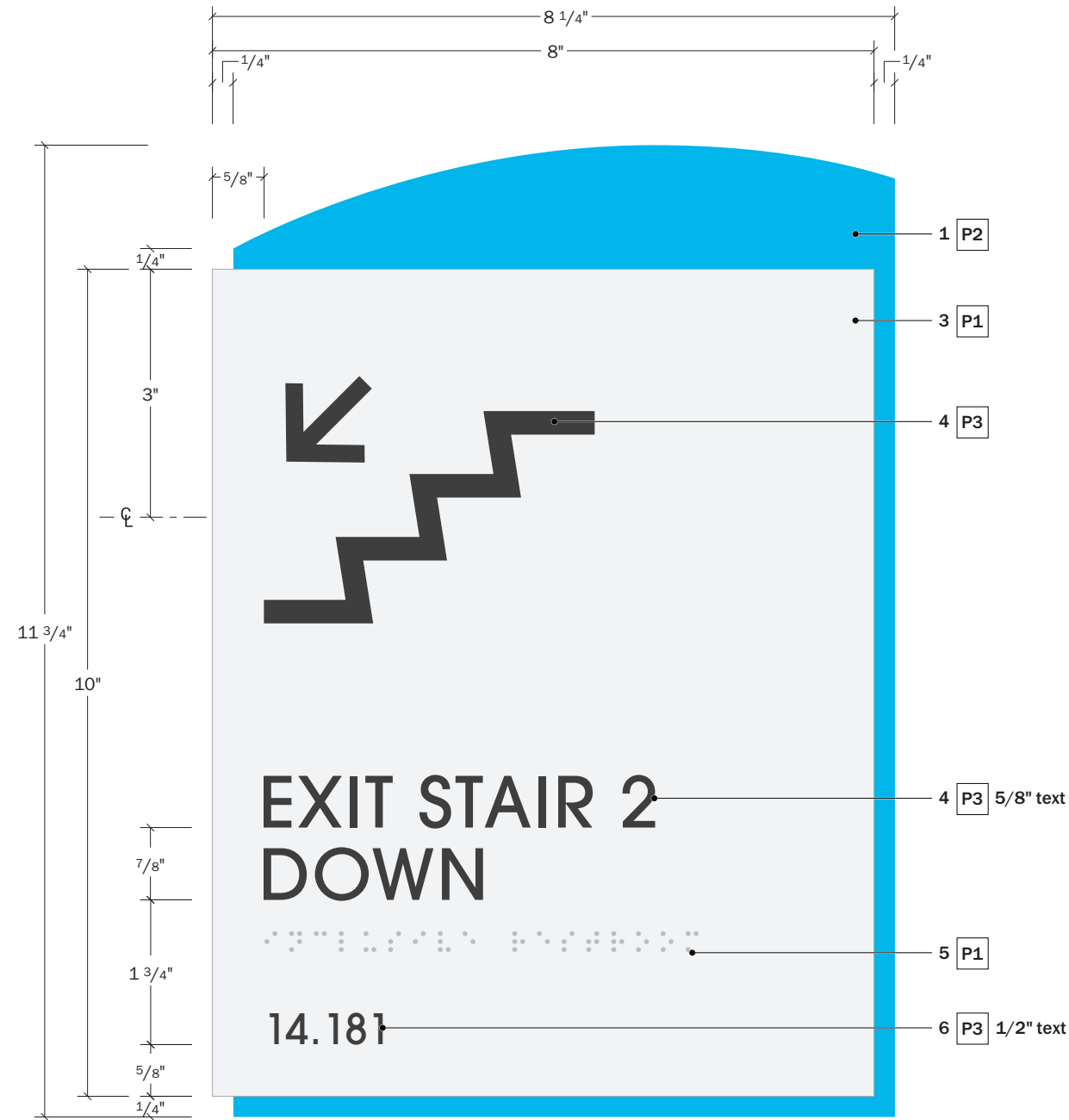
ADDITIONAL LAYOUTS
SCALE: 3"=1'-0"



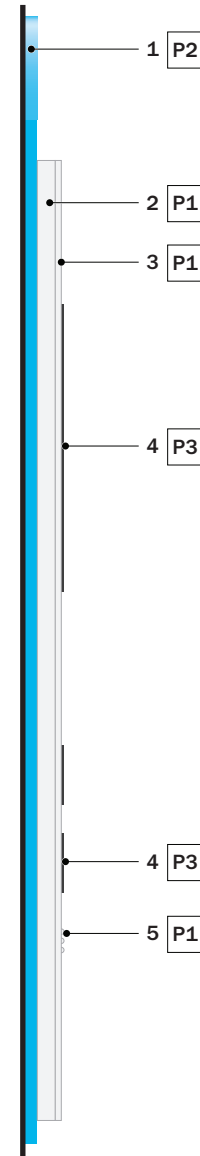
MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

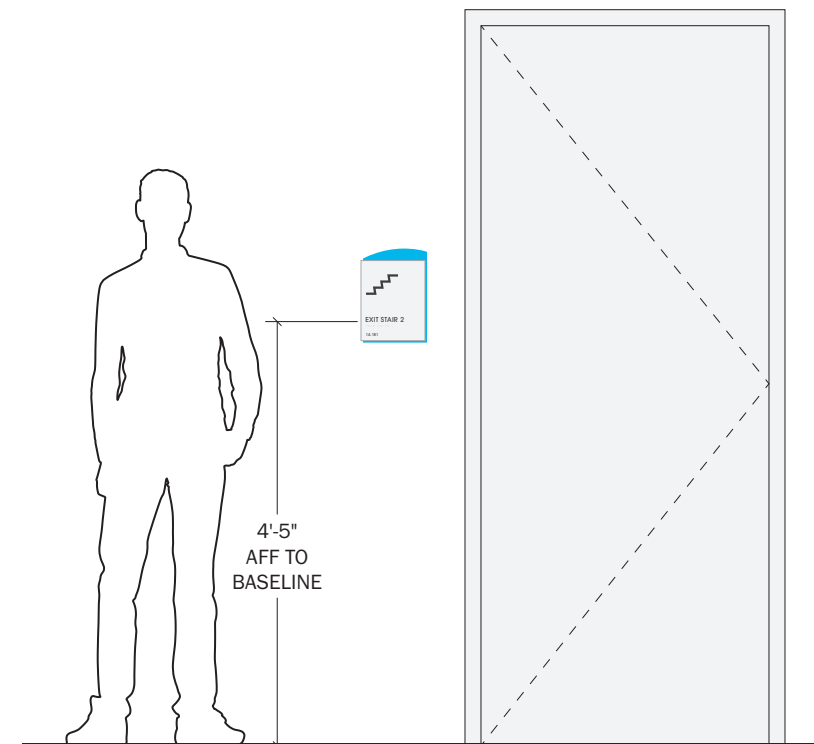
**SIGN TYPE H1.1
RESTROOM IDENTIFICATION
(EXTERIOR)**



FRONT VIEW
SCALE: Half Size



SIDE VIEW



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

DRAWING NOTES

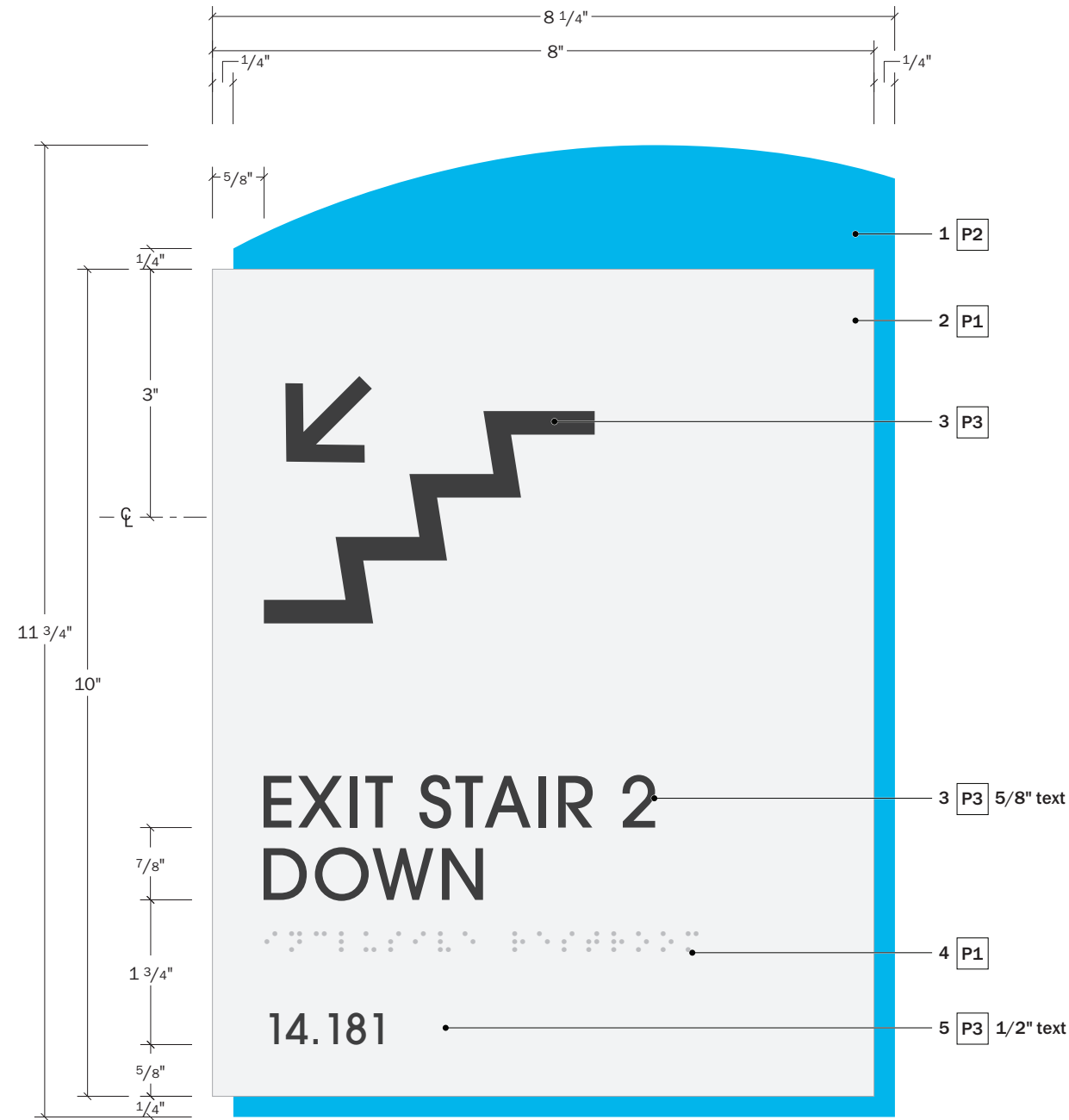
- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, acrylic core panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive.
 - 3 1/16" Thick, photopolymer face panel with paint finish on all sides. Panel has integrated raised lettering and braille. Panel is secured to core panel with full coverage, low-profile adhesive as required to prevent detachment.
 - 4 1/32" raised lettering and symbol per ADA guidelines. Lettering is integrated into photopolymer face panel. Lettering has silk-screened finish.
 - 5 Grade II braille integrated into photopolymer face panel. Braille to ADA guidelines. Translations by sign fabricator.
 - 6 Silk-screened room number on photopolymer panel. These letters are not raised and do not require braille.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).
- C This sign is intended for interior use only.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

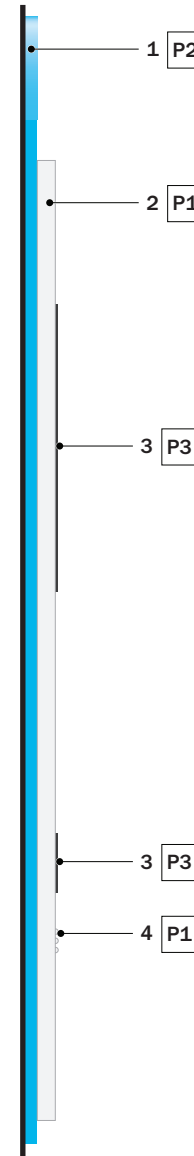
**SIGN TYPE H2
STAIR IDENTIFICATION
(INTERIOR)**

DRAWING NOTES

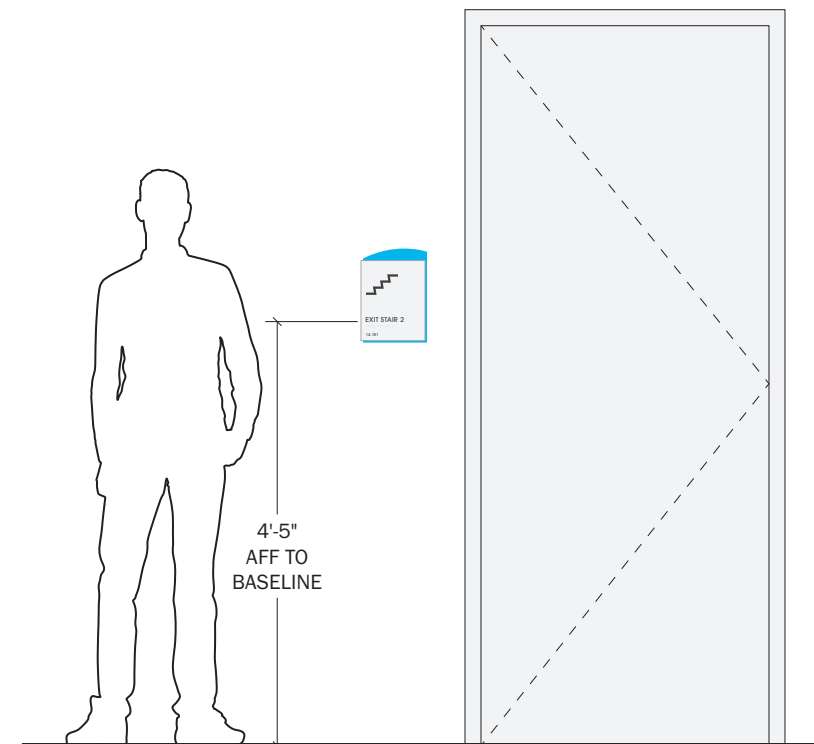
- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, chemically etched zinc sign panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive as required to prevent detachment. Sign panel has etched, raised lettering and braille.
 - 3 1/32" raised lettering and symbol per ADA guidelines. Lettering is integrated into zinc face panel. Lettering has silk-screened finish.
 - 4 Grade II braille integrated into zinc face panel. Braille to ADA guidelines. Translations by sign fabricator.
 - 5 Silk-screened room number on photopolymer panel. These letters are not raised and do not require braille.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).
- C This sign is intended for exterior use.



FRONT VIEW
SCALE: Half Size



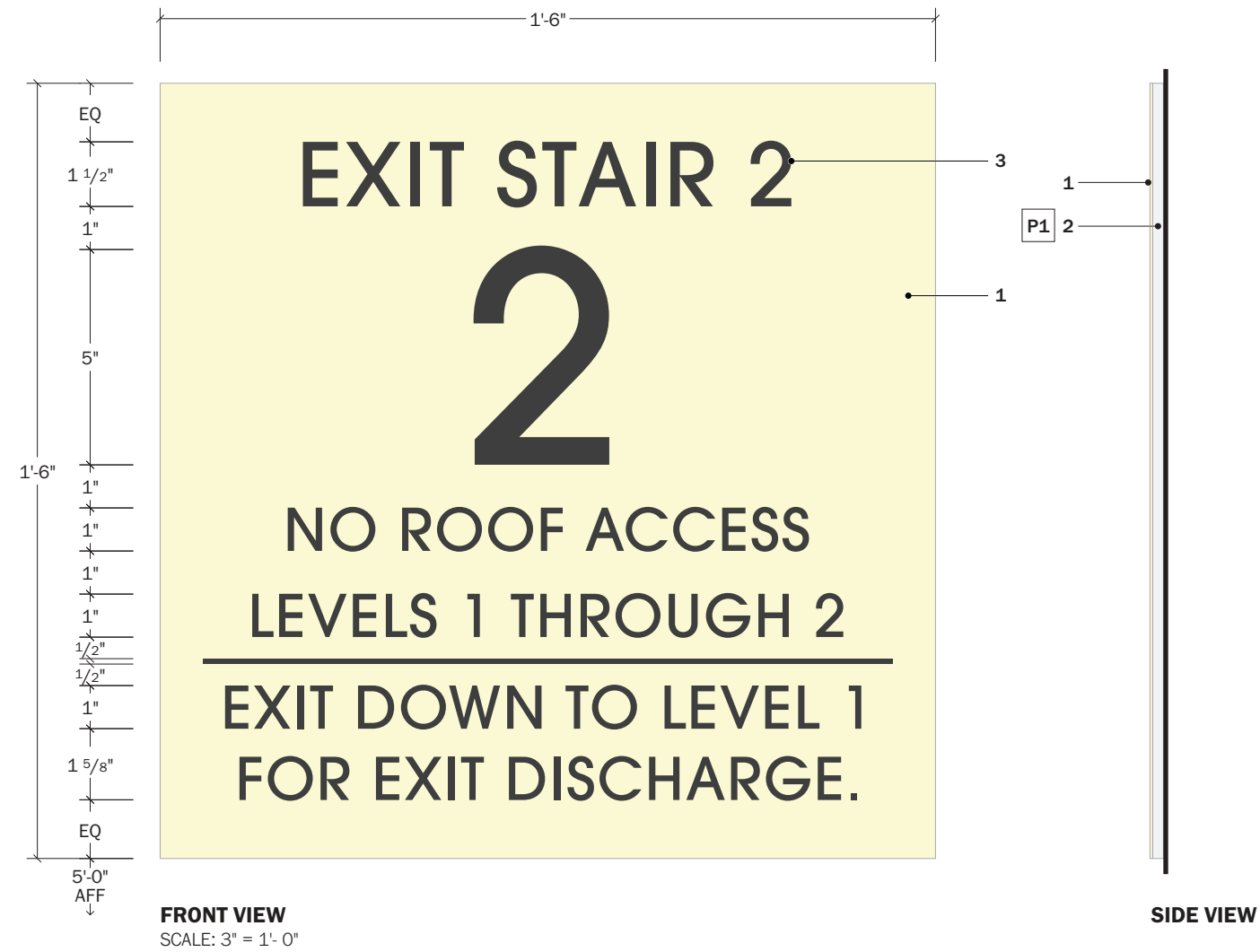
SIDE VIEW



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE H2.1
STAIR IDENTIFICATION
(EXTERIOR)**

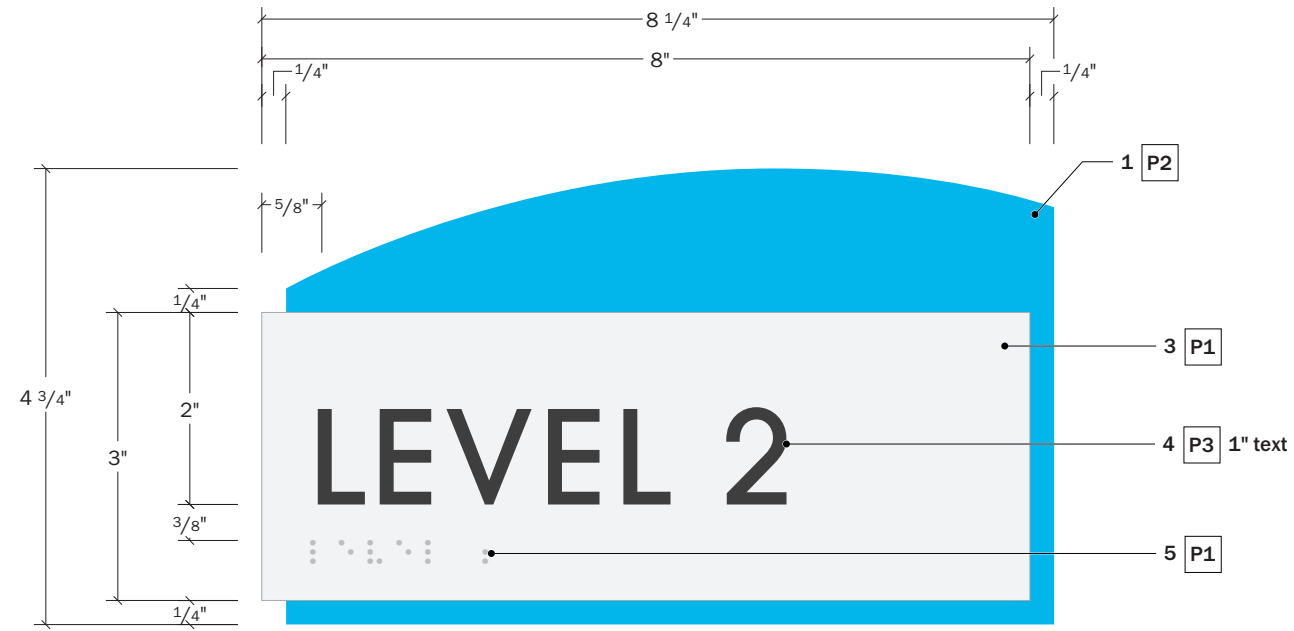


DRAWING NOTES

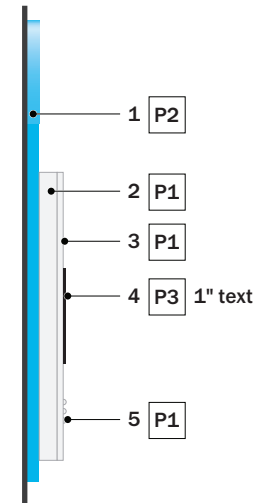
- 1 .05" thick, 2-ply LaserGlow Rotary Engravable material (or similar photoluminescent) sign face. Sign face has engraved messaging as shown. Sign face is applied to backer panel with full coverage adhesive.
 - 2 1/4" thick, acrylic backer with paint finish on all exposed surfaces. Backer panel is mounted to wall with VHB tape and silicone adhesive.
 - 3 Engraved sign messaging on sign face to reveal black layer below.
- A** Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B** Sign to be mounted within stairwell at stair landing in a position so that the sign is visible even when the door is held open.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

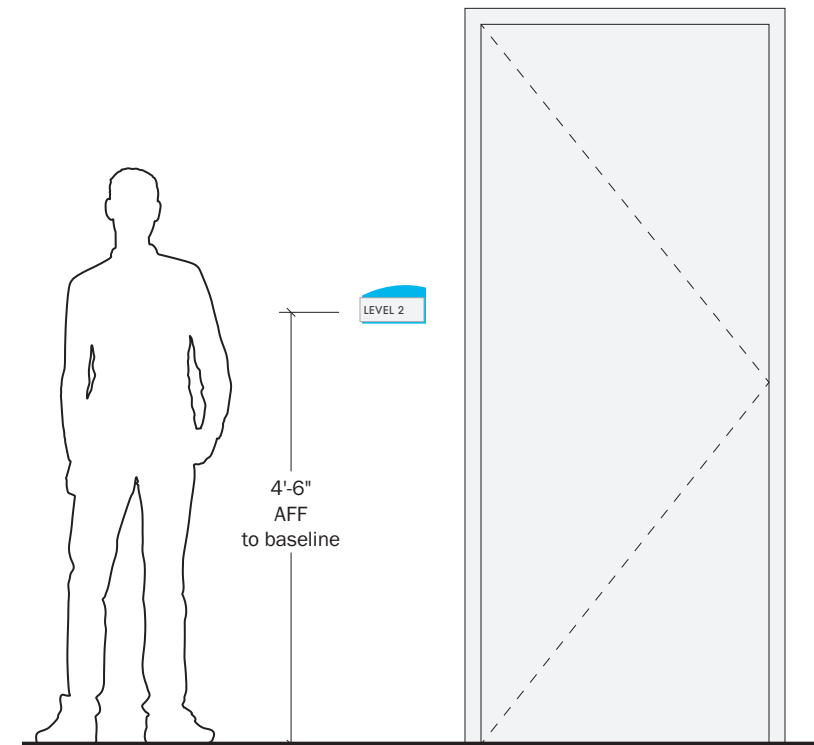
**SIGN TYPE H3
INTERIOR STAIRWELL
IDENTIFICATION**



FRONT VIEW
SCALE: Half Size



SIDE VIEW



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

DRAWING NOTES

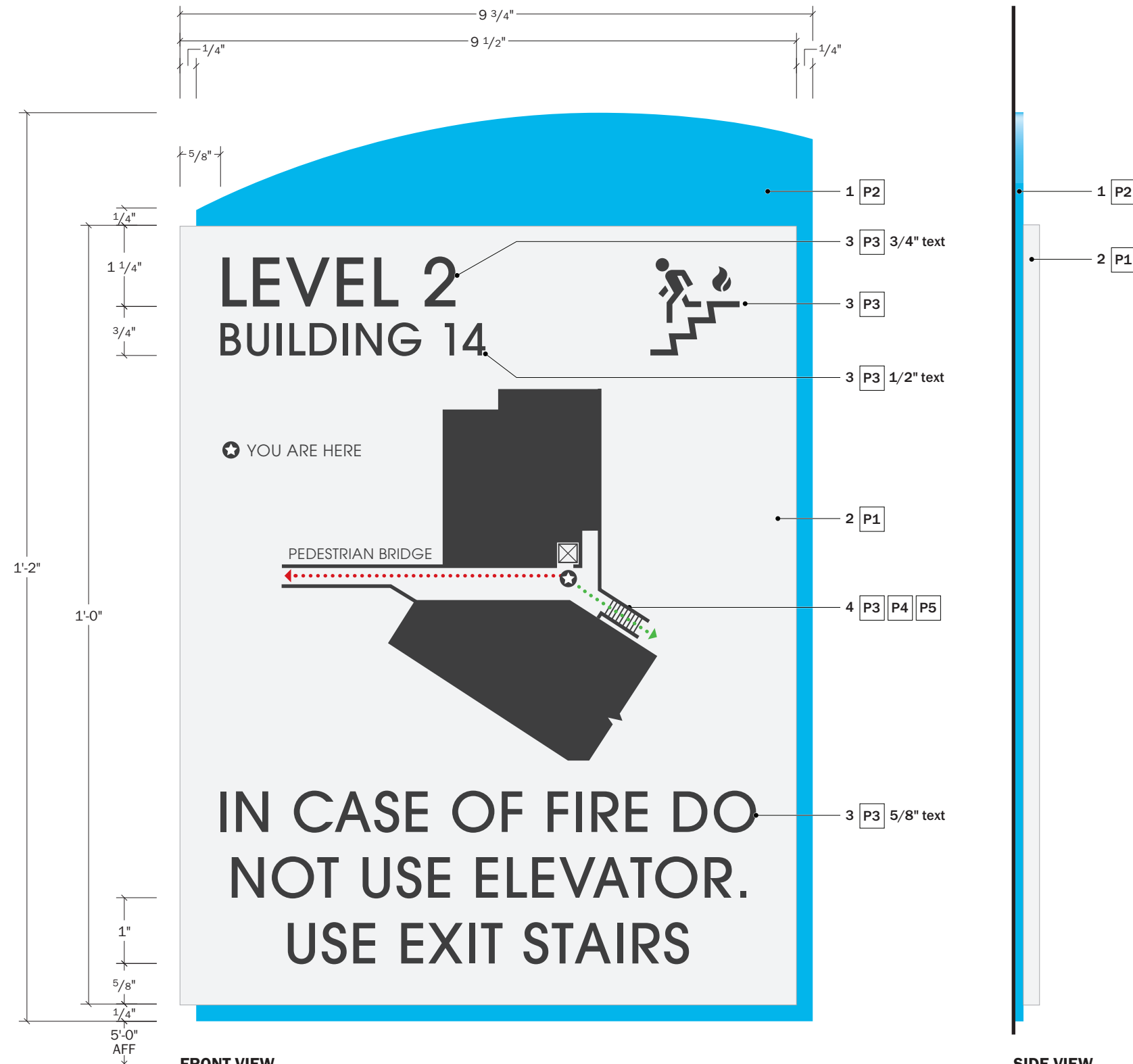
- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, acrylic core panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive.
 - 3 1/16" Thick, photopolymer face panel with paint finish on all sides. Panel has integrated raised lettering and braille. Panel is secured to core panel with full coverage, low-profile adhesive as required to prevent detachment.
 - 4 1/32" raised lettering per ADA guidelines. Lettering is integrated into photopolymer face panel. Lettering has silk-screened finish.
 - 5 Grade II braille integrated into photopolymer face panel. Braille to ADA guidelines. Translations by sign fabricator.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).
- C This sign is intended for interior use only.

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE H4
STAIR LANDING
IDENTIFICATION**

DRAWING NOTES

- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 1/4" Thick, acrylic sign panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive.
 - 3 Silk-screened copy and symbol on sign panel.
 - 4 Silk-screened egress map and legend on sign panel. Sign fabricator responsible for creating additional artwork for other locations. Map artwork to show a "YOU ARE HERE" symbol and two (2) paths of egress. Sign fabricator to coordinate receipt of architectural plans to generate additional map art from Architect/ or Owner prior to shop drawings. Map artwork to be oriented to viewer of sign.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B Sign is intended to be mounted above or near elevator call buttons. Confirm mounting locations in field and make adjustments as necessary within reason.
- C Map art shown is intended as map art style to be replicated for other locations. Intent is for egress paths (corridors) to be unfilled and areas not pertaining to egress, filled in. Egress paths to be show in dotted green and red lines.

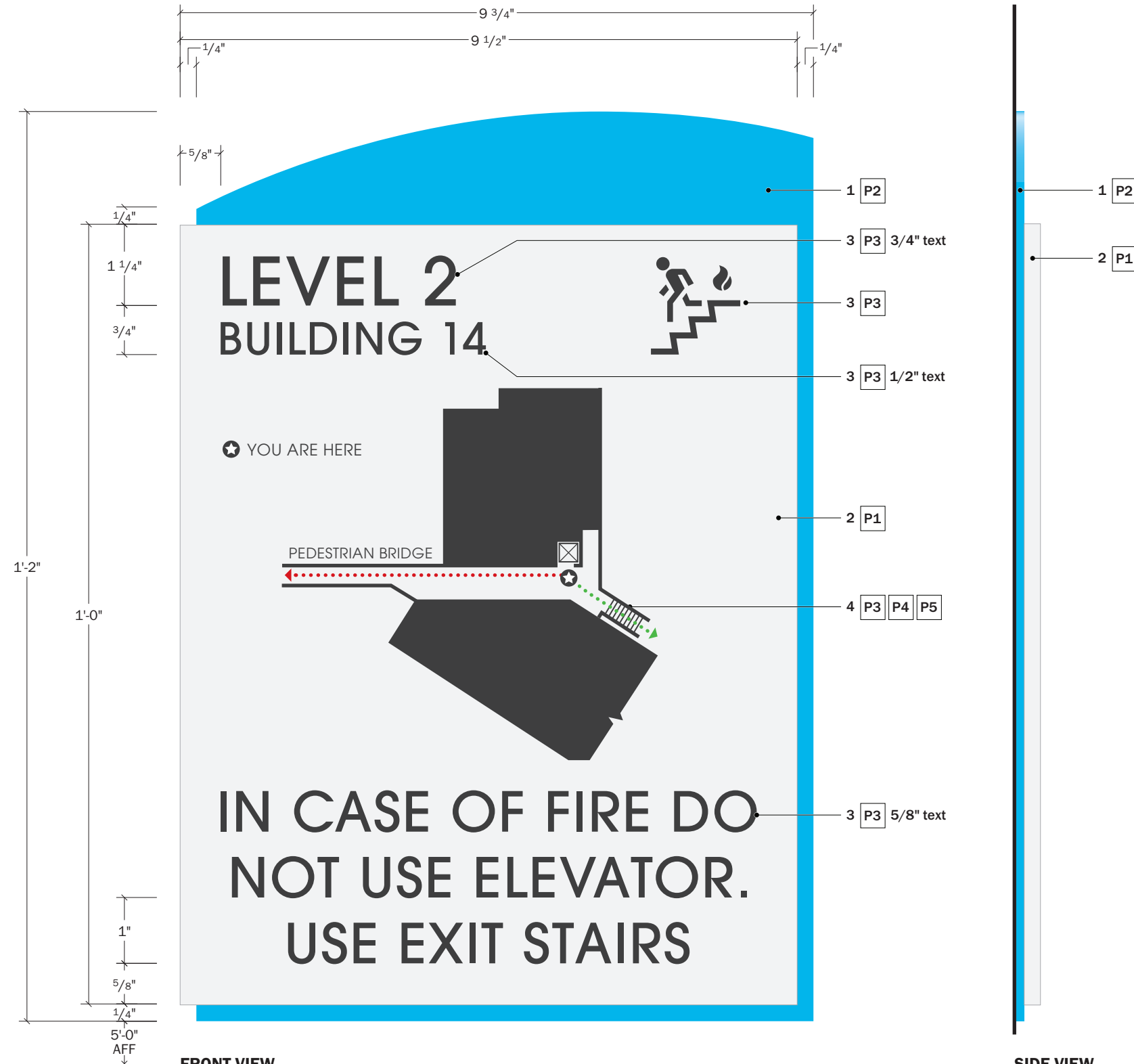


All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE H5
ELEVATOR EGRESS MAP
(INTERIOR)**

DRAWING NOTES

- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, chemically etched zinc sign panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive as required to prevent detachment. Sign panel has etched, raised lettering and braille.
 - 3 Silk-screened copy and symbol on sign panel.
 - 4 Silk-screened egress map and legend on sign panel. Sign fabricator responsible for creating additional artwork for other locations. Map artwork to show a "YOU ARE HERE" symbol and two (2) paths of egress. Sign fabricator to coordinate receipt of architectural plans to generate additional map art from Architect/ or Owner prior to shop drawings. Map artwork to be oriented to viewer of sign.
- A** Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B** Sign is intended to be mounted above or near elevator call buttons. Confirm mounting locations in field and make adjustments as necessary within reason.
- C** Map art shown is intended as map art style to be replicated for other locations. Intent is for egress paths (corridors) to be unfilled and areas not pertaining to egress, filled in. Egress paths to be show in dotted green and red lines.



FRONT VIEW
SCALE: Half Size

SIDE VIEW

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE H5.1
ELEVATOR EGRESS MAP
(EXTERIOR)**

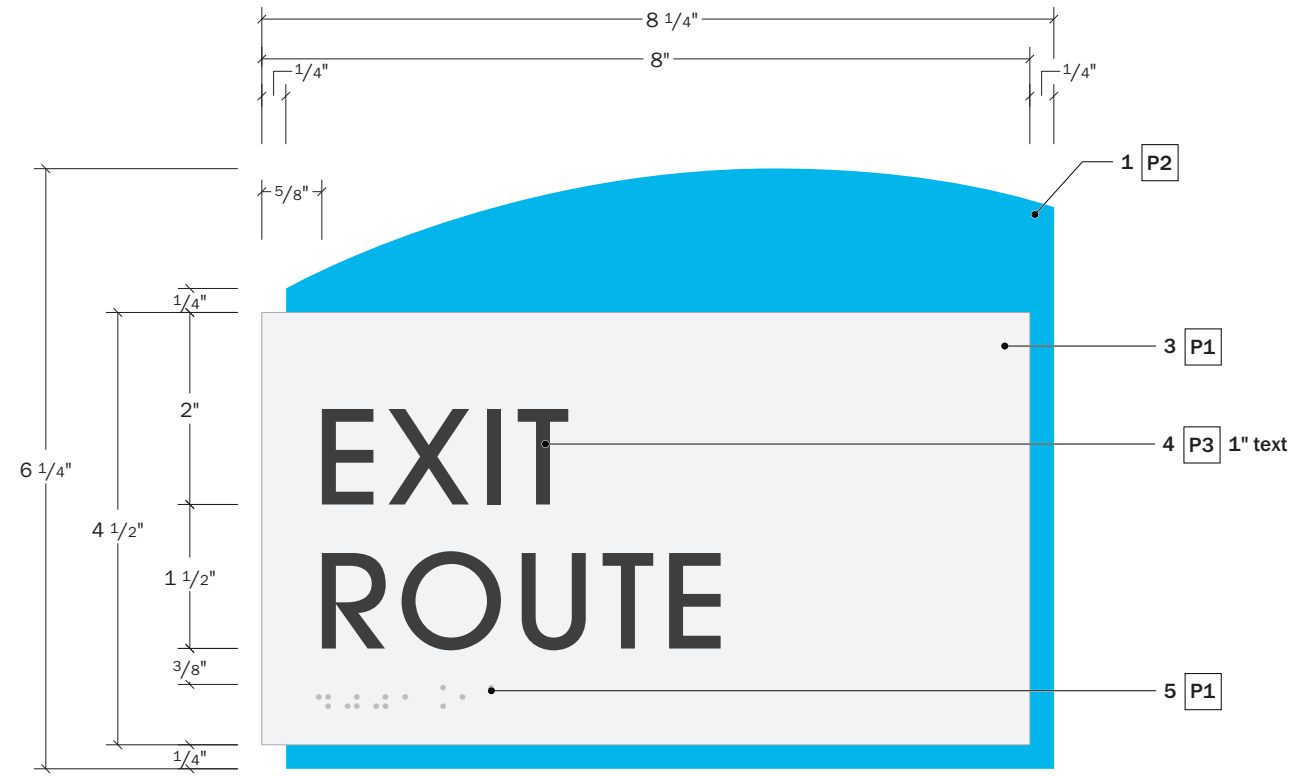
**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

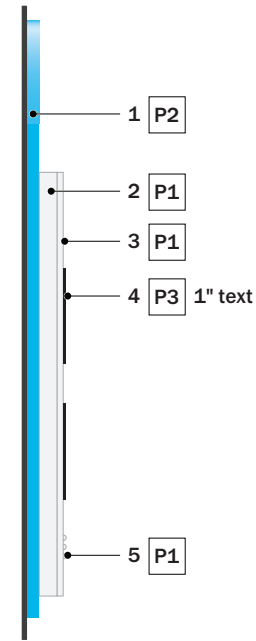
Preliminary Signage Standards Manual

DRAWING NOTES

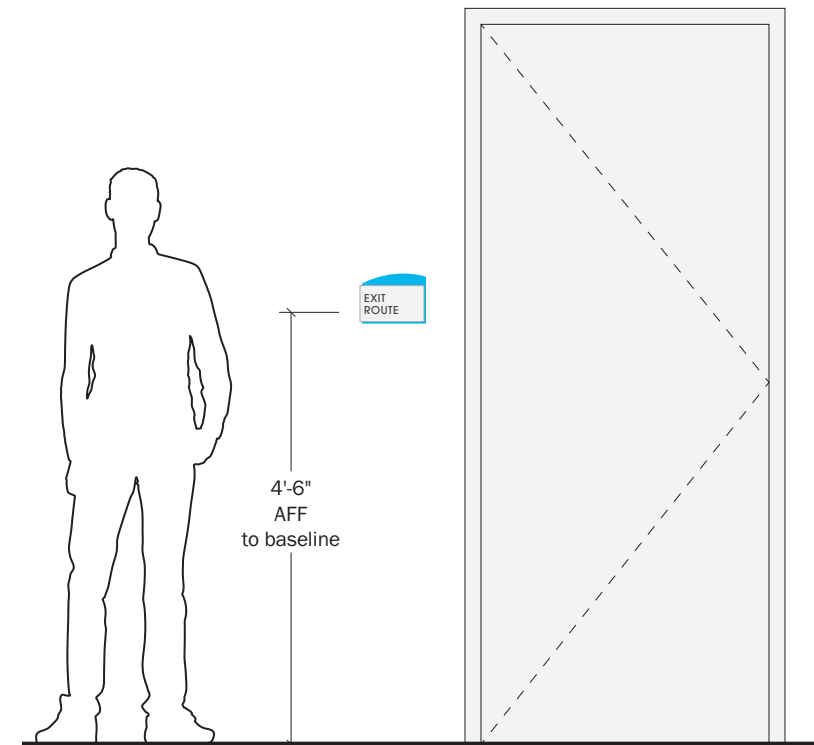
- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, acrylic core panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive.
 - 3 1/16" Thick, photopolymer face panel with paint finish on all sides. Panel has integrated raised lettering and braille. Panel is secured to core panel with full coverage, low-profile adhesive as required to prevent detachment.
 - 4 1/32" raised lettering per ADA guidelines. Lettering is integrated into photopolymer face panel. Lettering has silk-screened finish.
 - 5 Grade II braille integrated into photopolymer face panel. Braille to ADA guidelines. Translations by sign fabricator.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).
- C This sign is intended for interior use only.



FRONT VIEW
SCALE: Half Size



SIDE VIEW



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPE H6
ADA EXIT IDENTIFICATION**

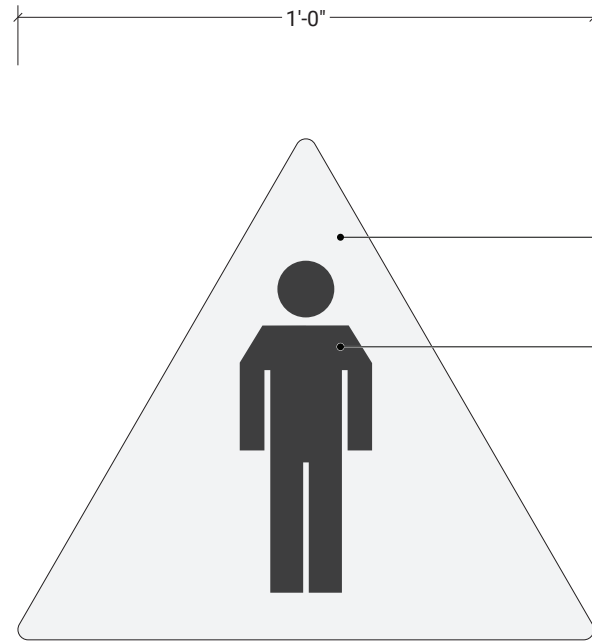
**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

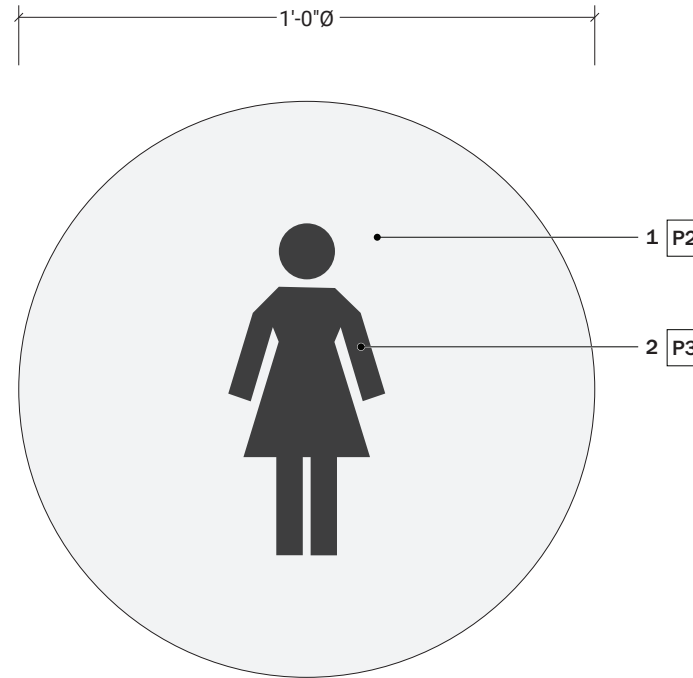
Preliminary Signage Standards Manual

DRAWING NOTES

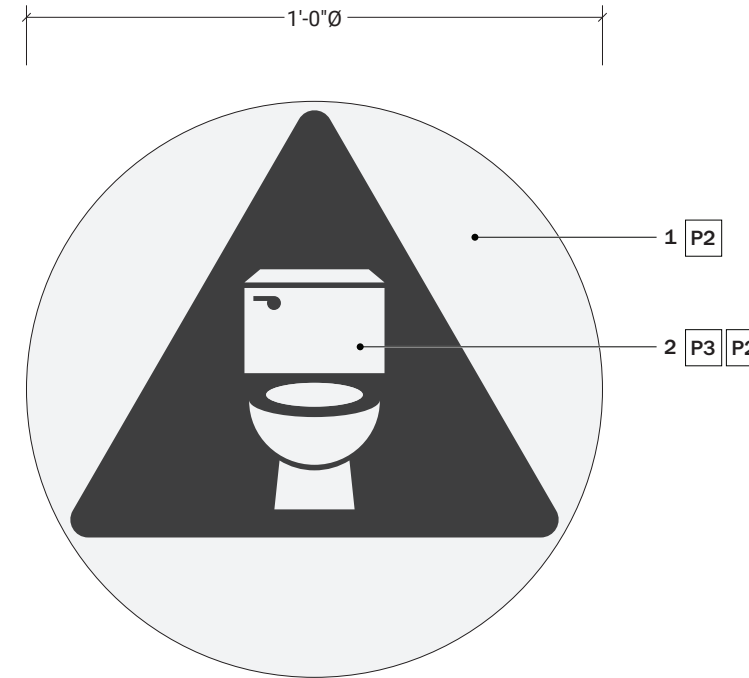
- 1 1/4" acrylic sign panel with paint finish on all sides. Sign panel is mounted to door with VHB tape and silicone adhesive to prevent detachment.
- 2 Silk-screened graphic on sign panel.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.



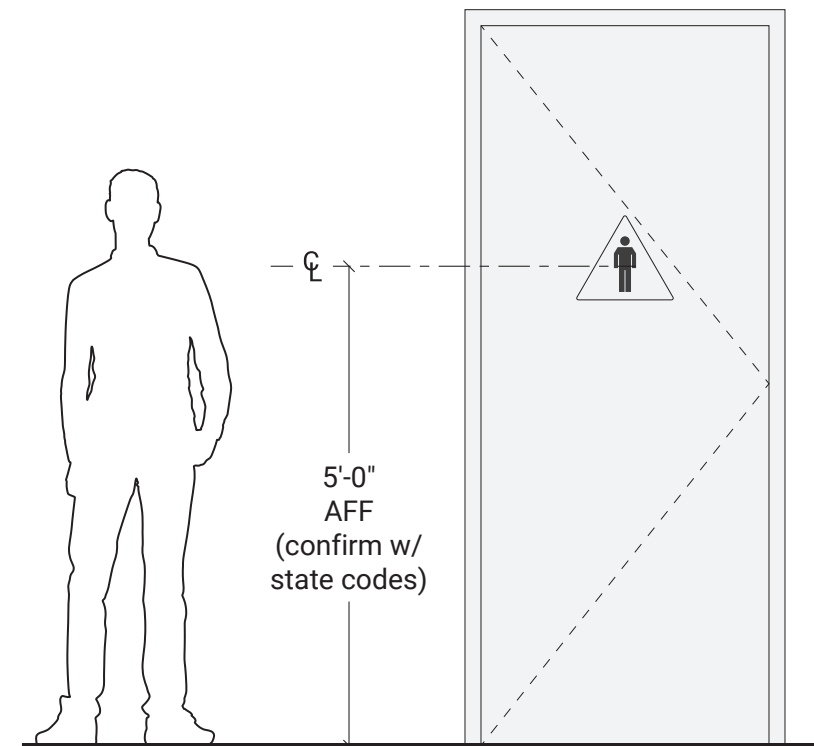
SIGN TYPE H8 - FRONT VIEW
SCALE: 3" = 1'-0"



SIGN TYPE H7 - FRONT VIEW



SIGN TYPE H9 - FRONT VIEW



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPES H7, H8, & H9
RESTROOM IDENTIFICATION
(DOOR MOUNT)**

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**

Oceanside, CA

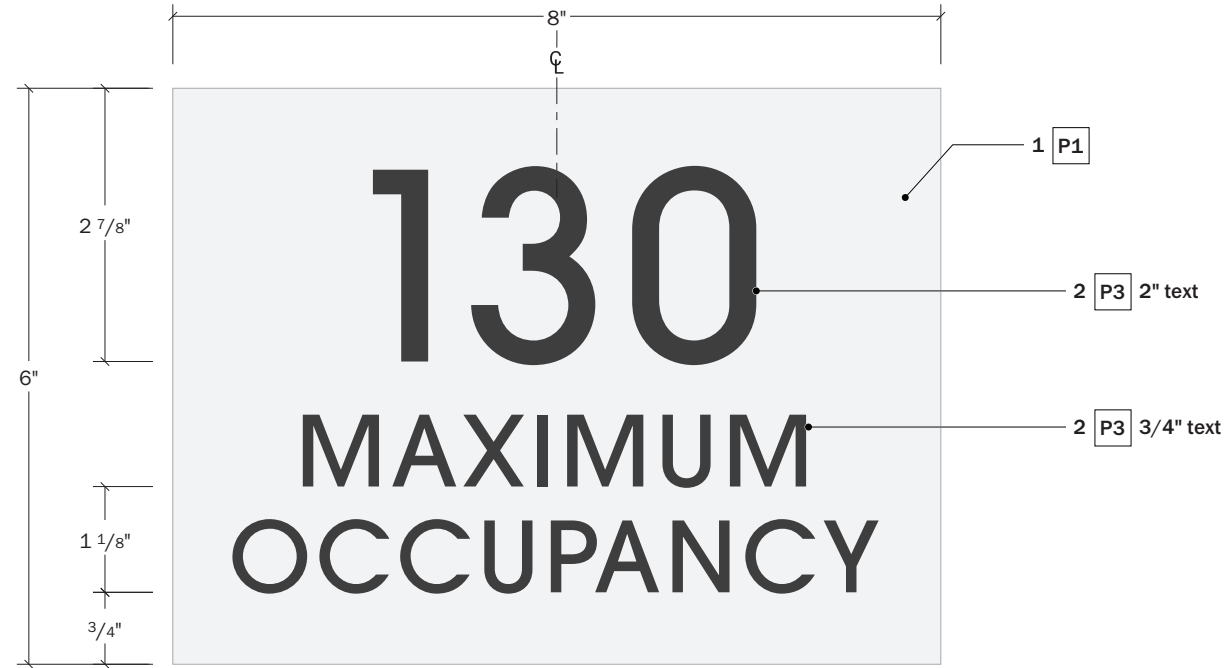
75-22602-00

July 18, 2023

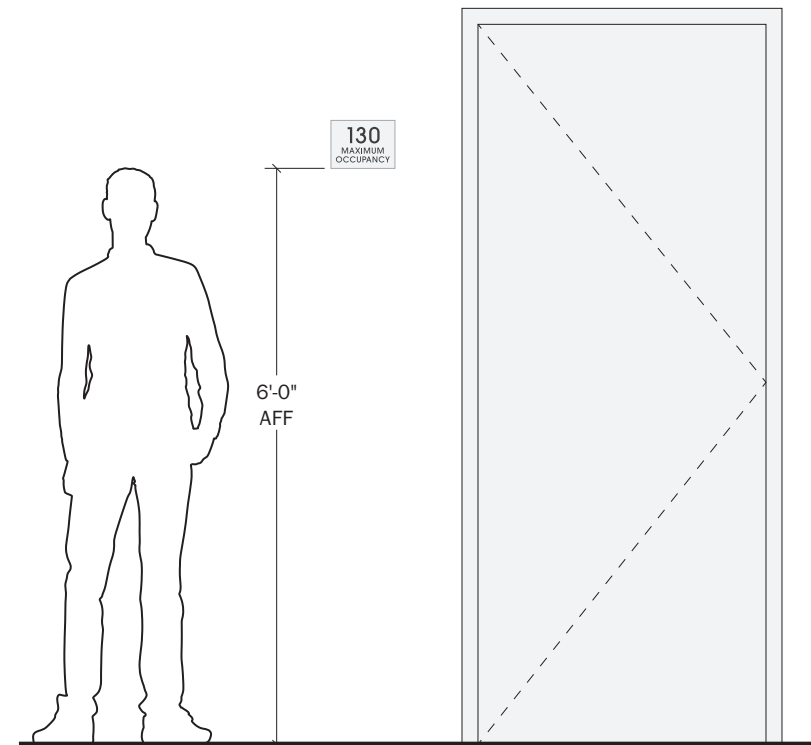
Preliminary Signage Standards Manual

DRAWING NOTES

- 1 3/16" Thick, acrylic sign panel with paint finish on all sides. Sign has silk-screened text graphics on sign face. Sign panel is mounted to wall with VHB tape and silicone adhesive.
- 2 Silk-screened text graphics on sign face.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).



FRONT VIEW
SCALE: Half Size



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

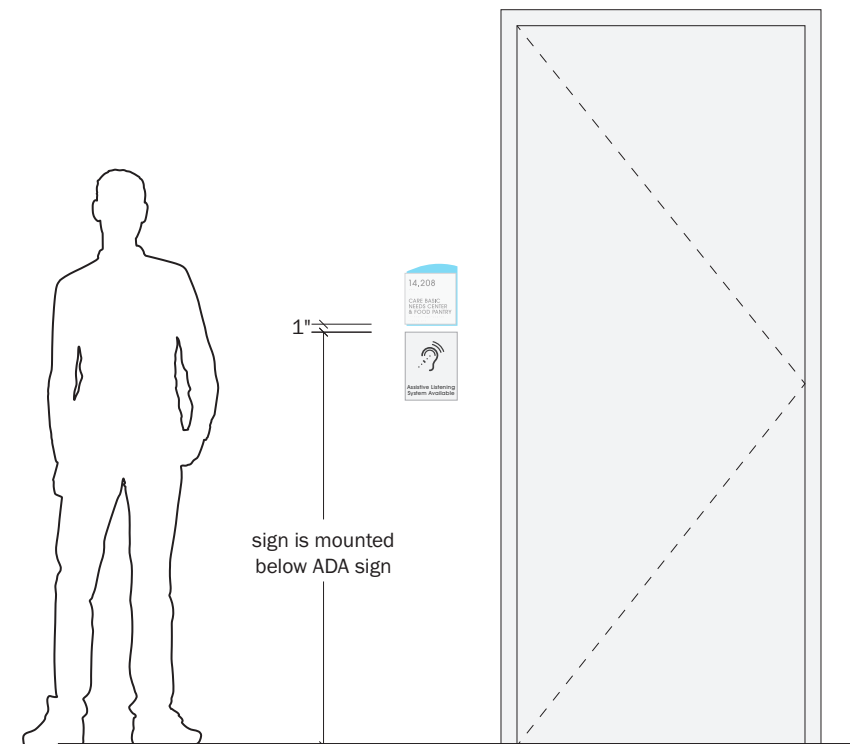
**SIGN TYPE H10
MAXIMUM OCCUPANCY**

DRAWING NOTES

- 1 3/16" Thick, acrylic sign panel with paint finish on all sides. Sign has silk-screened text graphics on sign face. Sign panel is mounted to wall with VHB tape and silicone adhesive.
- 2 Silk-screened text graphics on sign face.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).



FRONT VIEW
SCALE: Half Size



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

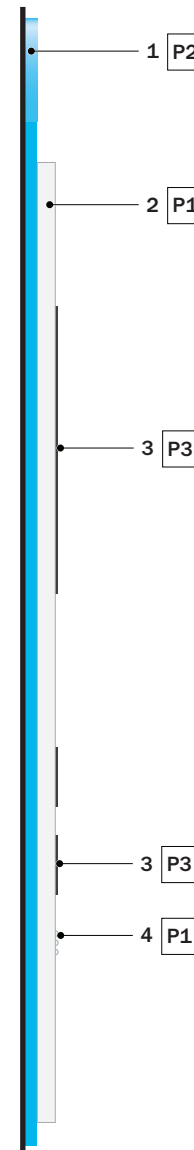
**SIGN TYPE H11
ASSISTIVE LISTENING SYSTEM
NOTICE**

DRAWING NOTES

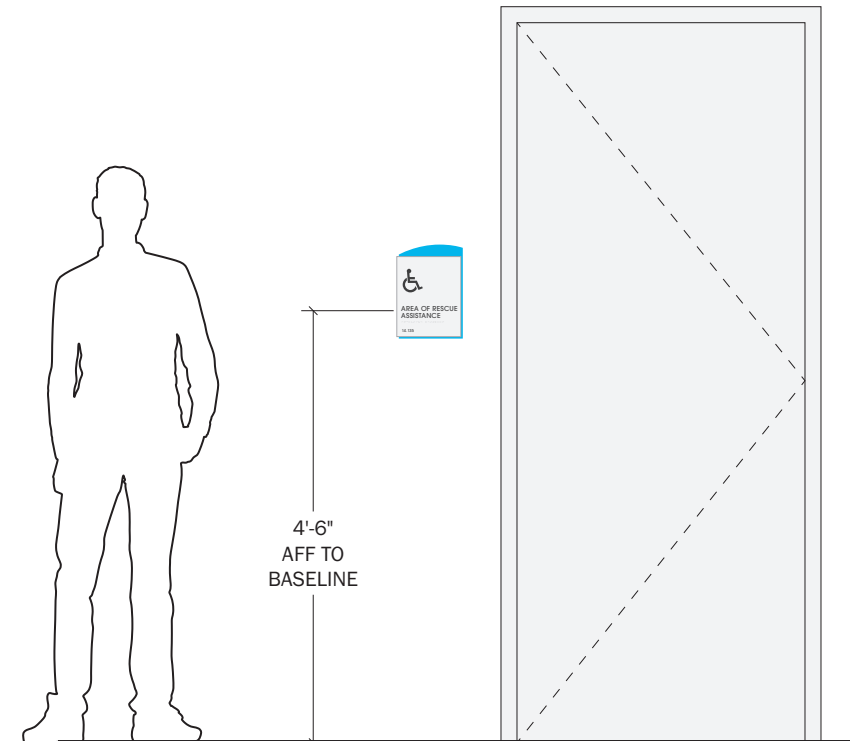
- 1 1/8" Thick, acrylic backer panel with paint finish on all sides. Backer panel has curve cut at top (curve to be same on all sign locations). Sign edges are sanded smooth as necessary to create smooth finish after paint. Sign is mounted to wall surface with VHB tape and silicone adhesive as required to prevent detachment.
 - 2 3/16" Thick, chemically etched zinc sign panel with paint finish on all sides. Core panel is secured to backer panel with full coverage, low-profile adhesive as required to prevent detachment. Sign panel has etched, raised lettering and braille.
 - 3 1/32" raised lettering and symbol per ADA guidelines. Lettering is integrated into zinc face panel. Lettering has silk-screened finish.
 - 4 Grade II braille integrated into zinc face panel. Braille to ADA guidelines. Translations by sign fabricator.
 - 5 Silk-screened room number on photopolymer panel. These letters are not raised and do not require braille.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B When sign is mounted to glass surface, light gray vinyl is to be applied, to glass prior to mounting sign to conceal mounting tape and adhesive. Vinyl backer is cut to same shape and size of sign backer (note 1 above).
- C This sign is intended for exterior use.



FRONT VIEW
SCALE: Half Size



SIDE VIEW



MOUNTING ELEVATION
SCALE: 1/2" = 1'-0"

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

SIGN TYPE H12
AREA OF RESCUE
ASSISTANCE/REFUGE

MiraCosta College District
Standards

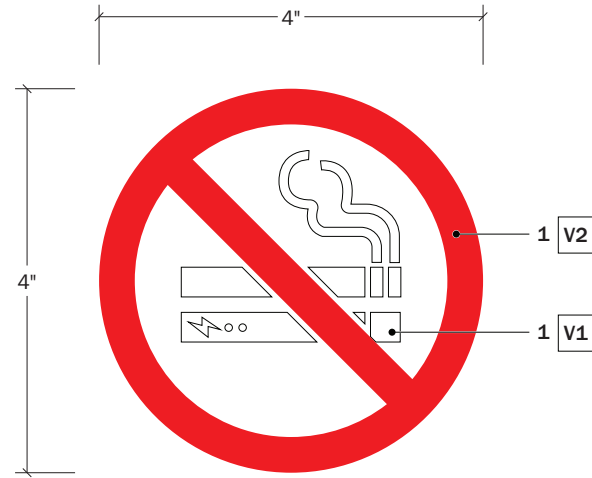
**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

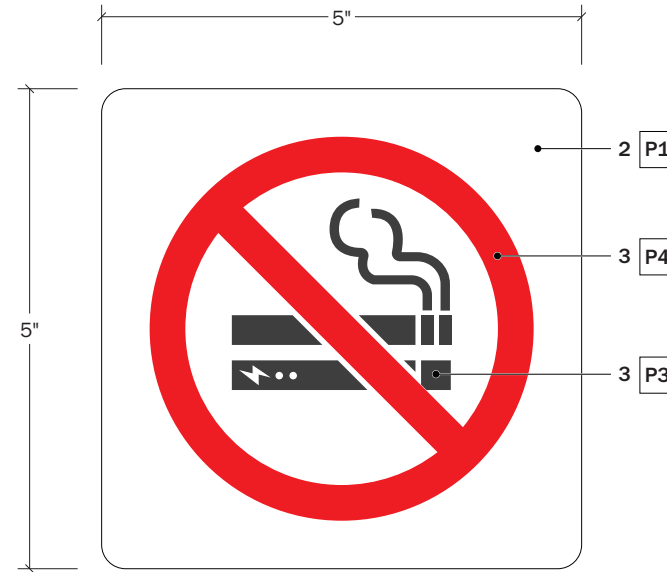
Preliminary Signage Standards Manual

DRAWING NOTES

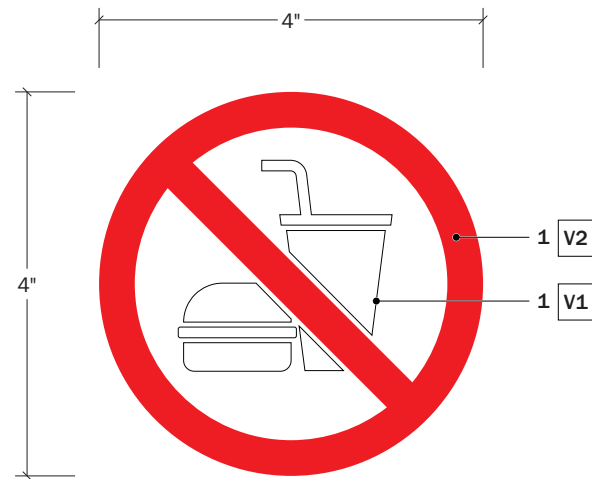
- 1 Applied vinyl graphics on window surface. Vinyl to be applied free of air bubbles, tears, folds, and creases.
 - 2 1/16" thick, aluminum sign panel with paint finish on all sides. Sign panel has masked and painted symbol graphics. Sign panel is secured to wall surface with VHB tape and silicone adhesive. Metal back-pins may be necessary in exterior applications where the wall surface is rough or uneven.
 - 3 Masked and painted symbol graphics on sign face.
- A Sign Mfr. to field verify mounting locations and adjust mounting per location as needed to accommodate variations in conditions.
- B Vinyl sign application to be used on glass surfaces only. Aluminum sign should be used only on solid, opaque wall surfaces.
- C Mounting height of sign to be determined upon field verification of each location. Typical height to be 5'-0" AFF to center of sign unless obstructions prohibit this height.



FRONT VIEW - SIGN TYPE J1
SCALE: Half Size



FRONT VIEW - SIGN TYPE J2
SCALE: Half Size



FRONT VIEW - SIGN TYPE J3
SCALE: Half Size



FRONT VIEW - SIGN TYPE J4
SCALE: Half Size

All artwork is for design intent only. Artwork shall not be used for production. All dimensions and locations are to be field verified.

**SIGN TYPES J1, J2, J3, J4
NO SMOKING NOTIFICATION
NO FOOD & DRINK NOTICE**

SECTION
05

Sign Location Plans

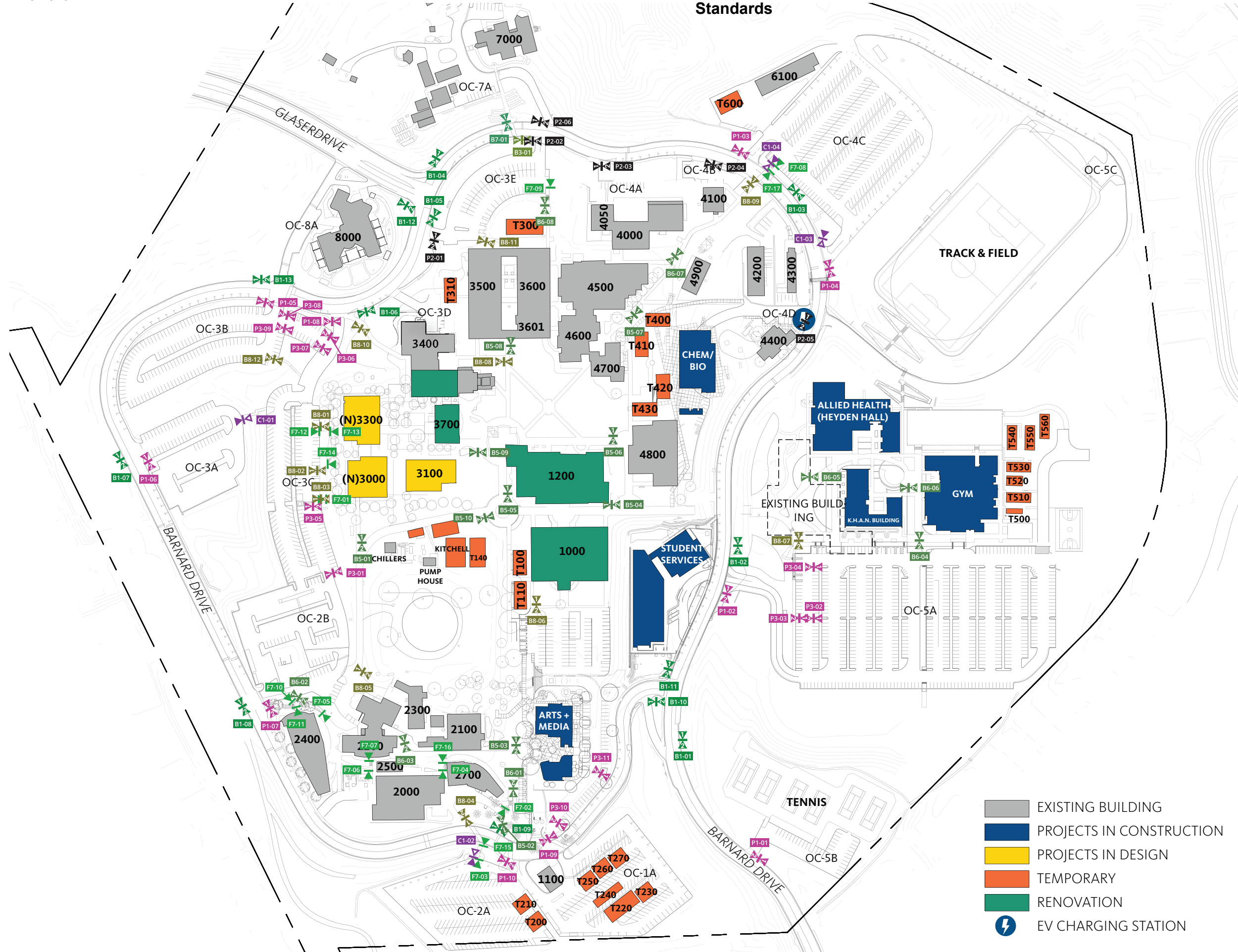
MiraCosta College District Standards

**MIRA COSTA CAMPUS-WIDE SIGNAGE
STANDARDS**
Oceanside, CA

75-22602-00
July 18, 2023

Preliminary Signage Standards Manual

SIGN	DESCRIPTION
B1	Primary Vehicular Directional
B2	Secondary Vehicular Directional
B3	Tertiary Vehicular Directional
B4	Vehicular Directional w/ LED
B5	Primary Pedestrian Directional
B6	Secondary Pedestrian Directional
B7	Tertiary Pedestrian Directional
B8	Primary Pedestrian Directional w/ map
C1	Campus Directory Map
P1	Primary Parking Lot Identification
P2	Secondary Parking Lot Identification
P3	Parking User Group Identification
P4	Parking Lot Identification (Pole Mount)
F7	Accessible Directional (Post Mount)



- EXISTING BUILDING
- PROJECTS IN CONSTRUCTION
- PROJECTS IN DESIGN
- TEMPORARY
- RENOVATION
- EV CHARGING STATION

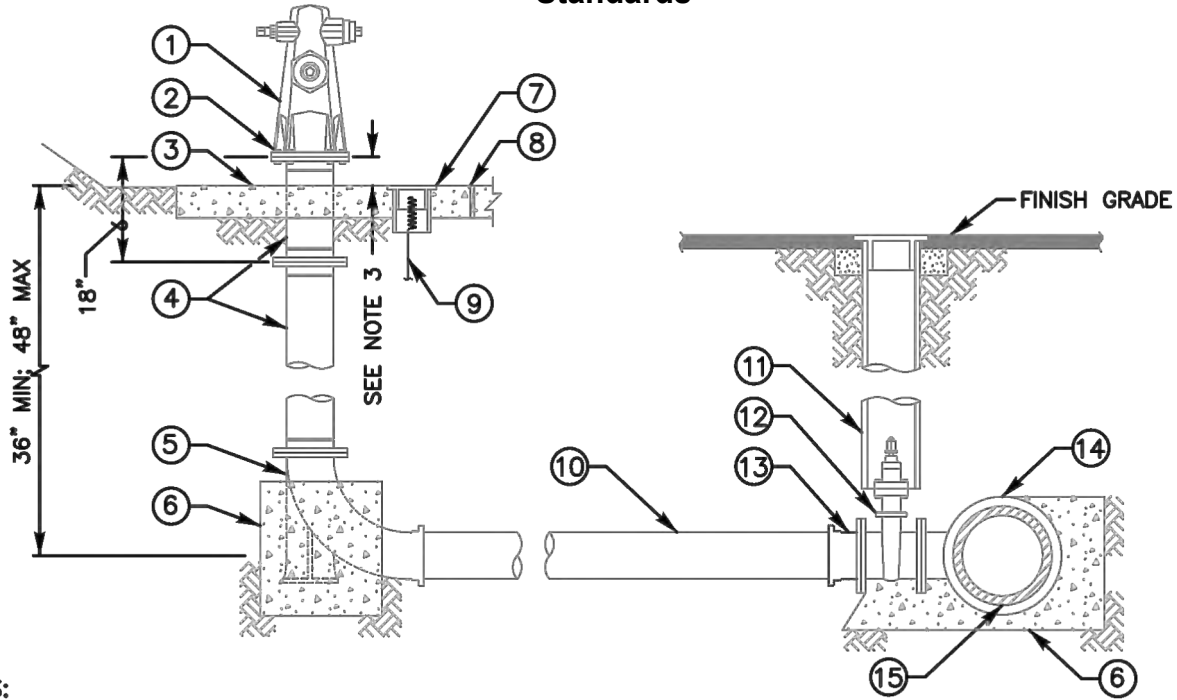
**SITE PLAN
WAYFINDING & PARKING ID
SIGNAGE**





APPENDIX 22 DIVISION 22 PLUMBING

MiraCosta College District
Standards



NOTES:

- 1) REFER TO AGENCY SPECIFICATIONS WHERE APPLICABLE
- 2) THE NUMBER OF OUTLETS SHALL BE AS SHOWN ON PLANS
- 3) FIRE HYDRANT FLANGE SHALL BE 6" ± 1" ABOVE TOP OF CURB OR SPLASH PAD SEE PLANS FOR ELEVATION
- 4) NOT USED
- 5) INSTALL WARNING/IDENTIFICATION TAPE
- 6) FIRE HYDRANT FLANGE BOLTS SHALL BE BREAK AWAY BOLTS INSTALLED WITH NUTS ON TOP OF THE FLANGE. BOLT SHAFT SHALL BE FILLED WITH SILICONE SEALANT
- 7) CONNECTIONS TO STEEL MAINS WILL BE MADE IN ACCORDANCE WITH AGENCY'S SPECIFICATIONS
- 8) MATERIALS SHALL BE SELECTED FROM THE AGENCY'S APPROVED MATERIALS LIST

ITEM NO	SIZE AND DESCRIPTION	ITEM NO	SIZE AND DESCRIPTION
①	6" FIRE HYDRANT SEE NOTE 2	⑧	COLD JOINT STRIP
②	BREAK-AWAY BOLTS, SEE NOTE 6	⑨	TRACER WIRE (AS REQUIRED) PER WP-01
③	4' x 4' x 6" THICK CONCRETE SPLASH PAD	⑩	6" C-900 PVC PIPE
④	6" FLANGE DI HYDRANT EXTENSION SPOOL(S) WITH BREAK OFF GROOVES (MAXIMUM OF 2 SPOOLS)	⑪	GATE WELL WITH CAP SEE WV-01 OR WV-02
⑤	6" x 16" LONG RADIUS FLG x MJ/PO BURY ELL	⑫	6" FLG x MJ/PO/FLG RWGV
⑥	CONCRETE THRUST BLOCK SEE WT-01	⑬	6" FLG x MJ/PO ADAPTER (IF REQUIRED)
⑦	TRACER WIRE ACCESS PORT, 4" x 8" LONG SDR 35 SEWER PIPE W/ CAP (AS-REQUIRED)	⑭	SIZE x 6" MJ/PO/FLG x FLG TEE
		⑮	WATER MAIN



STANDARD DETAILS

MiraCosta Community College
District

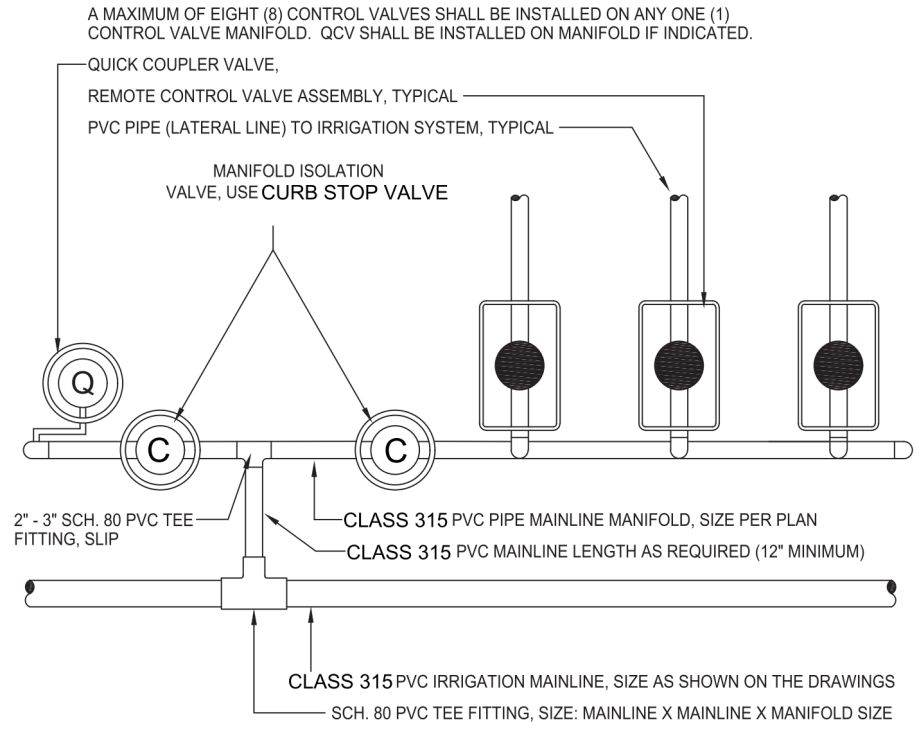
FIRE HYDRANT

Date 4/26/2022 9:42:46 AM


Scale 12" = 1'-0"

MCC-01

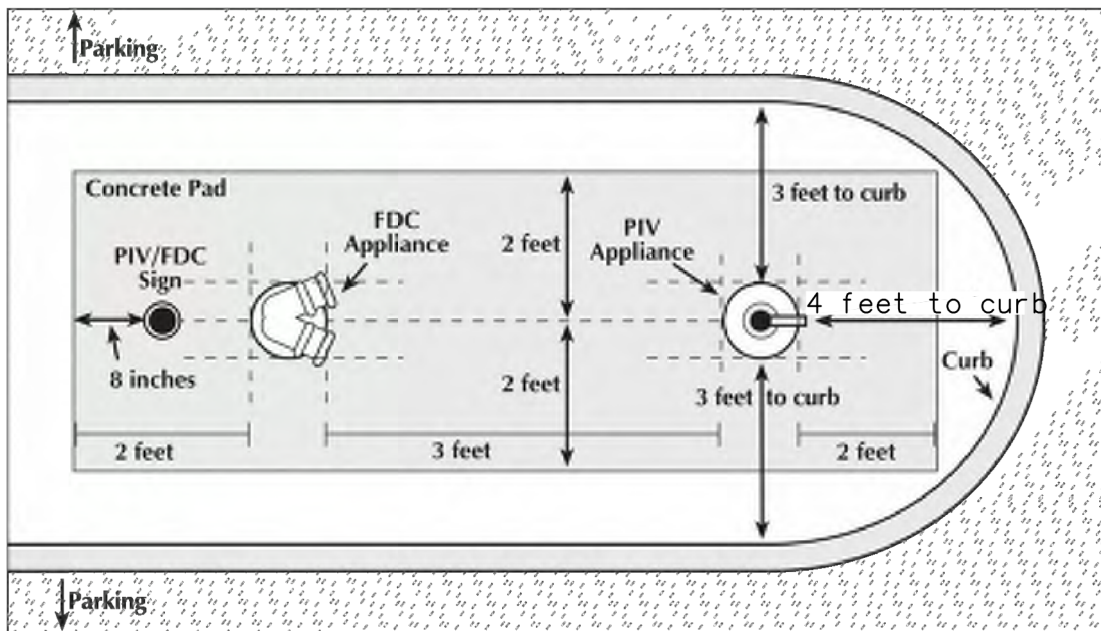
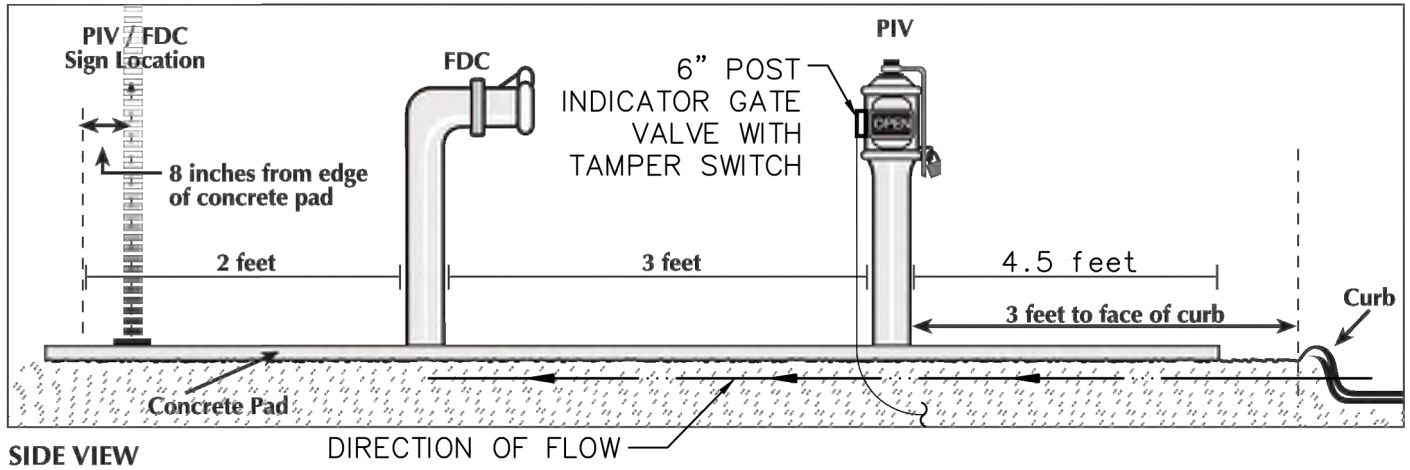
MiraCosta College District Standards



PLAN VIEW - N.T.S.

	STANDARD DETAILS	MANIFOLD LAYOUT	
	MiraCosta Community College District	Date	4/26/2022 9:42:47 AM
		Scale	12" = 1'-0"
			MCC-02

Concrete Pad PIV/FDC Detail



PIV/FDC Specifications

1. Measurements MUST be exact and will be subject to a field inspection
2. Fire Department appliances shall be no closer than 3 feet to the face of the curb
3. Concrete pad must be a minimum of 4 inches thick
4. A blue reflective marker must be in place to identify PIV/FDC location
5. THE POST INDICATOR VALVES (PIV) SHALL BE SET SO THAT THE TOP OF THE POST WILL BE 32" TO 40" ABOVE CONCRETE PAD SURFACE.



STANDARD DETAILS

MiraCosta Community College
District

FDC & PIV DETAIL

Date 4/26/2022 9:42:47 AM
Scale 12" = 1'-0"

MCC-03



APPENDIX 27 DIVISION 27 COMMUNICATIONS



APPENDIX 27 - DIVISION 27

CAMPUS COMMUNICATIONS DESIGN AND INSTALLATION GUIDELINES

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1. GENERAL

1.0. PURPOSE

The MiraCosta Community College District is looking to standardize all future new construction and renovation projects with consistency in the data network support infrastructure. This includes the structured cabling system and the telecommunications support spaces. The current District Data Center / Server Room is located on the Oceanside (OS) campus within the Library. The Secondary Data Center is located at the San Elijo (SE) campus. All new or renovated building's technology infrastructure will be designed to support access to technology systems by providing defined spaces for equipment rooms and cable pathways.

The intent of this document is to provide a standard for design and installation guidelines and best practices that will be used for all MiraCosta College (MCC) facilities requiring cable installation. This document provides the minimum performance criteria for the components and sub-systems comprising a complete cabling system that shall accommodate MCC's requirements.

Product specifications, general design considerations, and installation guidelines are provided in this written document. Quantities of telecommunications outlets, typical installation details, cable routing and outlet types for a specific MCC facility will be provided as an attachment to a Request for Proposal. If the bid documents are in conflict, the Request for Proposal specification shall take precedence. The successful vendor shall meet or exceed all requirements for the cabling system described in this document.

This document is intended to provide general design and installation guidelines for new construction, and performance criteria for additions/renovations to existing facilities.

This document is intended to be used in conjunction with MCC Specification Sections as required.

1.1. CONTRACTOR QUALIFICATIONS

Contractor must possess a valid State of California Contractor's License C-7 Low-Voltage and have successfully performed at least three projects of low voltage cable installation with similar size and work scope, within two years of the date of the job they are bidding on. Proof of performance shall be in the form of reference sheets which shall include a brief description of the project, the start and end dates, and contact information. For projects that require a Request for Proposal this information will be required as part of the submittal. See section 1.3. For work that does not require a Request for Proposal, this information should be available upon request.

All contractor personnel who will be performing work on this project shall have been trained in the work they will be performing. Contractor shall be certified by the manufacturers being installed and utilize manufacturer-trained technicians in compliance with the warranty requirements of the specific manufacturers.

Contractor's installers shall have been trained on the Contractor's company policies with respect to personnel safety, telecommunications industry cabling quality and neatness standards, and use of Construction Standard Institute (CSI)-standard specifications and drawings.

At MCC's discretion, on a project-by-project basis, an RCDD consultant may be hired by the College to inspect work during and after completion. Based upon the inspection by MCC's hired RCDD consultant or ITS staff the Contractor will be responsible for correcting any work that does not meet the requirements detailed in this document.

Contractor, at all times during performance and until work is completed and accepted, shall have on the premises a competent supervisor, satisfactory to the Customer and with authority to act for the Contractor.

Contractor must provide at least one lead technician on site at all times during project who is a BICSI certified installer and a BICSI member in good standing. For projects that require a Request for Proposal a copy of certificate and BICSI member number will be required as part of the submittal. See section 1.3. For work that does not require a Request for Proposal, this information should be available upon request.

Vendors must be certified installers of the MCC approved products used for installation. The warranty is required to cover cabling, components, and performance.

1.2. APPLICABLE REGULATIONS

A. RELATED DOCUMENTS

Equipment and material shall be Underwriter's Laboratories listed and labeled. The latest editions of the following standards are minimum requirements. If a conflict exists between applicable documents, then the order in the list below shall dictate the order of precedence in resolving conflicts. This order of precedence shall be maintained unless a lesser order document has been adopted as code by a local, state or federal entity, and is therefore enforceable as law by a local, state, or federal inspection agency.

1. ANSI/TIA-569-E Telecommunications Pathways and Spaces
2. ANSI/TIA 568.0-E Generic Telecommunications Cabling for Customer Premises
3. ANSI/TIA-568.1 -E Commercial Building Telecommunications Cabling Standard
4. ANSI/TIA-568.2-D Copper Components Standard
5. ANSI/TIA-568.3-D Optical Fiber Cabling Components Standard
6. ANSI/TIA-606-D Administration Standard for Telecommunications Infrastructure
7. ANSI/TIA-607-D Telecommunications Bonding and Grounding (Earthing) for Customer Premises
8. ANSI/TIA-1152-A Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling National Electrical Manufacturers Association (NEMA)
9. BICSI TDMM - Latest Edition
10. National Electrical Code, latest revision(NEC)
11. National Fire Protection Agency (NFPA) — 70
12. Local, State and Federal Codes
13. UL 497 Protectors
14. UL 1459 Standard for Safety for Telephone Equipment
15. UL 1863 Standard for Safety for Communications Circuit Accessories
16. UL 2024 Standard for Safety for Optical Fiber Cable Raceway
17. UL 723 Standard for Safety for Surface Burning Characteristics of Building Materials
18. UL 1581 Standard for Safety for Reference Standard for Wires, Cables and Flexible Cords
19. National Electrical Safety Code (NESC)

1.3. SUBMITTAL

- A. For jobs that require submittals, the Contractor shall furnish the following in a single consolidated submittal withan Approval copy to MCC Staff at the time of submission:
1. Contractor's license number and proof of qualifications.
 2. Reference sheets which provide three references. Each reference shall include a brief description of the project, the start and end dates, and contact information and contract value. The format shall be as follows for each of the three references:
 - Name of Client:
 - Address:
 - Contact Person:
 - Phone # :
 - Contact E-mail:
 - Description of Service/Project:

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Contract Price: \$ _____

Dates of Service/Project (Start to End Dates):

3. The make and model of the materials to be used.
- B. The Contractor shall furnish the following in a single consolidated submittal with an Approval copy to the Customer at the time of award:
1. A copy of the RCDD certificate and BICSI member number as described in the above Contractor Qualifications section.
 2. A copy of the BICSI certificate and the BICSI member number of the lead technician as described in the above Contractor Qualifications section.
 3. A copy of the BICSI certificate and the BICSI member number of the supervisor as described in the above Contractor Qualifications section.
 4. A copy of a valid manufacturer certified installer certification.
- C. The Contractor shall furnish the following in a single consolidated submittal with an Approval copy to MCC Staff upon request:
1. For all Category 6/6A installation technicians, provide the training certificates from the manufacturer being installed.

1.4. DESIGN REQUIREMENTS

Work must conform to the design requirement for each identified element.

A. BUILDING SERVICE

Plans for all new buildings shall include a design for extending the campus voice, data and video networks to the building. Consistent with this design, network trunks shall be extended as a part of the initial construction and equipment shall be installed to provide connection to the building. Every building, regardless of size, shall be constructed to allow for an air-blown fiber tube-cell conduit to enter through individual 4" conduits from the campus underground plant from two diverse locations. A minimum of two new tube cells shall be installed to any new building. Exact air-blown fiber tube-cell conduit size will be designed by the contractor and approved in writing by MCC Information Technology Services (ITS) on a project-by-project basis. Communication cables shall enter from the campus underground plant from two locations. In addition, every building shall be equipped with at least four 4" conduits to the campus underground plant. All raceways are to have 800 lb. nylon pull strings installed. All new service entrance conduits shall be a minimum 4" trade size and of sufficient number to provide 50% growth capacity and will terminate 4" above finished floor in the Building Distribution Frame (BDF) inside the building.

Data communication service to each building shall consist of a minimum of 12 strands of 8.3/125-micron single-mode fiber and terminated at two separate major distribution locations on campus as determined by MCC ITS. Fiber optic cable is to be contained in its own air-blown fiber tube-cell conduit. Single-mode fiber is to be terminated with LC style connectors, UPC. Single-mode fiber will be terminated in a separate rack-mounted fiber optic enclosure. Contractor will install an air-blown fiber distribution unit in all BDF and IDF locations. Each fiber optic enclosure must be labeled with building name, IDF room number, and fiber enclosure identifier of opposing end. Patch panels to be mounted in such a manner as to allow the maximum usage of each rack. Appropriate wire management, determined by consultation with MCC ITS and with regards to building design, shall be installed. Service loops of fiber-optic cable will be coiled, to meet manufacturer specifications, at both termination points.

B. VAULTS

All new cable vaults shall be as specified in Specification Section 27 10 00 and as detailed in drawings or ITS approved equivalent and encased in concrete. All cables are to have service loops and be racked and mounted. Each vault shall have drainage holes and be engineered so water will not accumulate. Vault lids shall be adjustable torsion spring assisted openings with safety latches, lift handles, and hold down bolts. Top of vault lids shall be flush with paved areas, or 4" above finished grade in landscaped areas. Vault lids shall be Traffic Rated. Maximum spacing between vaults should not exceed 450ft.

C. CABLE SPLICING

Copper cable splicing is not allowed. Any exceptions must be approved by MCC ITS in writing. Fiber- optic cable will only be spliced at the termination point. Fiber-optic splicing must be fusion based with two fibers optic strands of the exact make and model on each end using factory terminated connectors on pigtails. Splicing is not acceptable outside of Tele/Data rooms.

Epoxy based splices shall not be acceptable.

The following cable splicing techniques and materials for copper cable shall be utilized:

1. Preparation for Splices

All copper cables shall be thoroughly cleaned and scuffed in a manner to insure a good mechanical bond when splicing. 3M Scotchcast 4435 non-conductive aluminum oxide abrasive strip, or MCC approved equal shall be used. All cable shall be thoroughly cleaned with a nontoxic solvent, 3M Scotchcast 4414 or 4415 or MCC approved equal.

2. Splicing requirements

- a. No splice cases will be permitted in cable trays.
- b. All splice closures for use on underground non-pressurized systems shall be manufactured of clear, self-extinguishing, tongue and groove fitting PVC.
- c. End caps must be tapered and flexible and be capable of separate cable entries.
- d. Rigid bonding and strain relief bars must be an integral part of the finished closure.
- e. Re-enterable, polyurethane compound shall be used.
- f. All cable splices must be tagged or marked showing the cable number and pair count spliced. Markings may be placed on the splice closure or on both the in and out cables.
- g. Supports: All cable splices shall be supported by a minimum of two cable hooks. Horizontal racking for support may utilize 3M Brand RC-100 rack adapters, manhole racks, or MCC approved equivalent.
- h. Closures: 3M or PLP splice closures or MCC approved closures will be used for splicing throughout the system.
- i. Protection: All cable splices must be protected from damage at sheath openings by mechanically protecting all conductors utilizing 3M Scotchcast Pair Saver 4458 or approved equivalent.

D. BUILDING DATA TERMINAL ROOMS

All new building structures shall have a minimum of one primary Telecommunication Room (TR) in which the outside cable terminates, henceforth referred to as the Building Distribution Frame (BDF). Each building may have additional data rooms for end wiring, henceforth referred to as Intermediate Distribution Frame (IDFs).

1. BUILDING DISTRIBUTION FRAME (BDF) SPECIFICATIONS

- a. The BDFs shall not contain any equipment not specified by MCC ITS. This includes, but is not limited to, equipment, transformers, sinks, fire, or building alarm equipment. They shall be kept clear of all other equipment.
- b. Each BDF will be provided with an isolated electrical panel with 200-amp service.
- c. It is required that the electrical feed to the BDF be backed up by a generator, including all convenience outlets to conform with the current NFPA code.
- d. Outlets and faceplates with the generator feed shall be and labeled with the panel designation and position of the servicing electrical panel.
- e. The BDF will require the installation of a secondary bonding busbar (SBB) to building primary bonding busbar (PBB) that is directly bonded to the AC electrical ground system with a conductor the same size as the largest telecommunications bonding backbone (TBB). The connections of the telecommunications bonding conductor (TBC) and the TBB to the PBB shall utilize exothermic weld, Listed compression two-hole lugs, or two-hole exothermic lugs. All equipment racks shall be connected to the secondary bonding busbar (SBB) with a telecommunications bonding conductor (TEBC) that is a continuous copper conductor not less than #6 AWG.

The SBB shall:

- Be provided with holes for use with correctly matched listed lugs and hardware. Be made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the International Annealed Copper Standard (IACS).
- Have minimum dimensions of 1/4 in. (6.35mm) thick by 2 in. (50mm) wide and shall be long enough to accept all current connections with additional room for growth.
- Be listed.
- Where a backbone bonding conductor (BBC) is required, it shall be bonded to the SBB.
- The BDF will require the installation of a rack bonding busbar (RBB) connected with a rack bonding conductor through a telecommunications equipment bonding conductor (TEBC) using an irreversible compression connector sized to match the conductor gauges. The TEBC is then bonded directly to the SBB that is a continuous copper conductor not less than #6 AWG.

The RBB shall:

- Be provided with holes for use with correctly matched listed lugs and hardware.
 - Be made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the International Annealed Copper Standard (IACS).
 - Have minimum dimensions of 3/16 in. (4.76mm) thick by 3/4 in. (50mm) wide and shall be 19 in. (482.6mm) long.
 - Shall mount to the back-rack rails at the top of each rack.
- f. Each BDF will have duplex 20 amp, 110 V.A.C. outlets, terminated with NEMA 5-20Rs, located at 6' intervals and 18" AFF around the room.
 - g. Provide one L6-20R 20A 208V and one 20A 120V outlet for each installed rack. Outlet shall be mounted on the side of cable runway, be on separate A and B circuits and be supported from a centralized UPS.
 - h. All BDFs shall be accessible only from inside the building. No outside entrances are permitted. All doors between the outside and the BDF must be at least 36" wide and 80" high.
 - i. Rooms will be rectangular or square, have a minimum clearance height of eight feet without obstructions (sprinklers, etc.), be at least 12' wide x 14' long', and not have false floors or ceilings.

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- j. No exposed water or gas pipes shall enter or run through the main terminal room or data room. No drains, ducts or clean-outs will be permitted.
- k. A separate HVAC thermostat control will be installed for all BDF rooms and shall be air conditioned with separate zone or air conditioning unit 24 hours a day, seven days a week. A positive pressure shall be maintained with a minimum of one air change per hour.
- l. All BDFs shall be secured using an MCC-approved card access reader and striker. The access of which is to be managed by the ITS Department and/or Maintenance Department.
- m. All BDFs shall be provisioned with at least four standard data racks, as manufactured by CPI, bolted to the floor. These rack(s) shall be placed side-by-side, with vertical cable management, in between and on both sides. Vertical cable management shall have doors on both front and rear of the cable managers. The racks must have a minimum of 36" of clearance front and back and at least 36" on one side. Please refer to Specification Section 27 10 00 for Rack and cable management specified CPI part numbers.
- n. Ladder rack shall be provided and installed sufficient to secure the equipment rack to the adjacent wall(s) as determined at installation and to provide support for incoming cables.
- o. All walls must be covered by A-C fire retardant plywood, see typical BDF room requirements drawing.
- p. Floors should be covered with static dissipating VTC tile. Floor rating shall be 100 lbf/ft under distributed loading and 2000lbf/ft for a concentrated loading.
- q. Provide adequate and uniform lighting that provides a minimum equivalent of 50 foot-candles when measured 3' AFF. Locate light fixtures a minimum of 9' AFF. Locate light switches near the room entrance. Emergency lighting systems which operate on trickle-charge storage batteries are desirable as a safety precaution in the event of an inadvertent power outage. Power for the lighting should not come from the same circuits as power for the telecommunications equipment.
- r. All other elements of the room to be designed and provisioned per ANSI/TIA 569-E or better.

2. INTERMEDIATE DISTRIBUTION FACILITY (IDF)

- a. The IDFs shall not contain any equipment not specified by MCC ITS. This includes, but is not limited to, transformers, sinks, fire or building alarm equipment. They shall be kept as clear of all other equipment.
- b. Each IDF will be provided with an SBB connected by a TBB to the PBB. The TBB shall be no smaller than a #6 AWG conductor and/or use the recommended sizes in accordance with ANSI-TIA-607-C. All equipment racks shall be connected to the SBB with a TEBC that is continuous copper conductor not less than #6 AWG. The SBB shall:
 - Be provided with holes for use with correctly matched listed lugs and hardware.
 - Be made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the International Annealed Copper Standard (IACS).
 - Have minimum dimensions of 1/4 in. (6.35 mm) thick by 2 in. (50.8mm) wide and shall be long enough to accept all current connections with additional room for growth.
 - Be listed by authority having jurisdiction.
 - Where a backbone bonding conductor (BBC) is required, it shall be bonded to the SBB.
- c. The IDF will require the installation of a rack bonding busbar (RBB) connected with a rack bonding conductor through a telecommunications equipment bonding conductor (TEBC) using an irreversible compression connector sized to match the conductor gauges. The TEBC is then bonded directly to the SBB that is a continuous copper conductor not less than #6 AWG.

The RBB shall:

- Be provided with holes for use with correctly matched listed lugs and hardware.
- Be made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the International Annealed Copper Standard (IACS).
- Have minimum dimensions of 3/16 in. (4.76mm) thick by 3/4 in. (50mm) wide and shall be 19 in. (482.6mm) long.

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- Shall mount to the back-rack rails at the top of each rack.
- d. Each IDF will have at least two quad 30 amp, 110 V.A.C. outlets, terminated with NEMA L5-20Rs and two 30 amp 208 V.A.C. outlets, terminated with NEMA L6-30Rs. All outlets will require dedicated electrical circuits. When available, all outlets will be serviced by the emergency power system and colored orange or otherwise marked as such.
- e. All IDFs shall be accessible only from inside the building. No outside entrances are permitted. All doors between the outside and the IDF must be at least 36" wide and 80" high.
- f. Rooms will be rectangular or square, have a minimum clearance height of nine feet without obstructions (sprinklers, etc.), be at least 11' wide x 12' long, and not have false floors or ceilings.
- g. No exposed water or gas pipes shall enter or run through the main terminal room or data room. No drains, ducts or clean-outs will be permitted.
- h. A separate HVAC thermostat control will be installed for all IDF rooms and shall be air conditioned with separate own zone or air conditioning unit 24 hours a day, seven days a week. A positive pressure shall be maintained with a minimum of one air change per hour.
- i. All IDFs shall be secured using a MCC -approved card access reader and striker. The access of which is to be managed by the Campus Facilities Department and/or Maintenance Department.
- j. All IDFs shall be provisioned with at least three standard data racks, as manufactured by CPI, bolted to the floor. These rack(s) shall be placed side-by-side, with vertical cable management in between and on both sides. Vertical cable management shall have doors on both front and rear of the cable managers. The racks must have a minimum of 36" of clearance front and back and at least 36" on one side. Please refer to Specification Section 27 10 00 for Rack and cable management specified CPI part numbers.
- k. Enough rack space must be provided to terminate all fiber and copper, with associated cable management, plus enough open space equivalent to the number of rack units already utilized by copper and fiber cabling. For example: If 36 rack units were used for fiber and copper patch panels including the rack units between panels left open for network equipment, there must be at least 36 rack units of open space in the remaining rack(s) for future equipment.
- l. Ladder rack shall be provided and installed sufficiently to secure the equipment rack to the adjacent wall(s) as determined at installation and to provide support for incoming cables.
- m. All walls must be covered by A-C fire retardant plywood, see typical IDF room requirements drawing.
- n. Floors should be covered with static dissipating VTC tile. Floor rating shall be 100 lbf/ft under distributed loading and 2000lbf/ft for a concentrated loading.
- o. All other elements of the room are to be designed and provisioned per ANSI/TIA 569-E or better.

3. ROOM SIZING

- a. There shall be a minimum of one Telecommunication Room (TR) per floor. One additional TR for each area up to 10,000 sq. ft. shall be provided when the floor area to be served exceeds 10,000 sq. ft or the horizontal distribution distance to the end device exceeds 295-feet including external camera mounts and access control at entry doors.
- b. If the floor area is over 10,000 sq. ft., then the TR size shall be increased, based upon 0.75 sq. ft. for every additional 100 sq. ft. of usable space the TR will support.
- c. Server room sizing shall be coordinated with MCC ITS based on the number of buildings being supported.
- d. The sizes of all telecommunications spaces (BDF/IDF) listed are minimum requirements. Depending on the requirements and services performed by the building occupants, additional space may be required. Larger size buildings and building programs may require additional rows of equipment racks or cabinets. Contact the College's ITS Representative for specific instructions and approvals.

Table 1: Telecommunications Space Dimensions

Serving Area	Minimum Room Size
IDF	11-feet wide by 12-feet long

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BDF

12-feet wide by 14-feet long

F. BUILDING INTERIORS

1. UNDERGROUND PLANT

The cables from the underground plant shall enter the building in a BDF room. Appropriate wire management shall be installed such as ladder racks, D-rings, and hook and loop tape so as not to exceed the acceptable cable bend radius.

2. Telecommunication Rooms

Additional IDF(s) shall be provided on each floor, and if necessary, to prevent total length of copper data cable runs from exceeding 295 feet. IDF rooms in multistory buildings shall be aligned vertically with the BDF room, if possible.

3. INTERNAL BACKBONES (RISERS)

A minimum of four 4" EZ-PATH Series 44+ modular floor grid system between every IDF and the BDF within buildings. Pull strings shall be provided in every conduit. Data interconnections between each IDF and the BDF shall be via fiber optic cable containing a minimum of 12 strands of single-mode fiber. Fiber optic cable is to be an armored interlocked cable with a yellow plenum rated sheath. Patch panels are to be mounted in such a manner as to allow the maximum usage of each rack. All fiber to utilize LC connectors. Refer to Specification 27 10 00 for additional requirements.

4. STATION WIRING

a. Data Outlets:

- All outlets shall be constructed using single gang, 2-port or 4-port stainless steel faceplates. All outlets shall have at least two Category 6 network drop each, black in color. The remaining open ports shall have blank inserts.
- Vendor shall refer to MCC AV Standards to ensure that cable locations being used for AV purposes meet campus standards.

b. Copper Cabling:

- All station cabling shall be connected with black Cat 6 network cabling from patch panels to each drop location and terminated on black data jack. All Wireless cabling should be connected with black Cat 6A networking cabling from patch panel to each location terminated on black data jack. Every cable shall be continuous and unspliced, with data cables attached to a single port in the patch panel at one end and to a single jack at the station end. All connections are to be terminated using the T568B wiring scheme. No cable run from patch panel to connection point may exceed 295 feet. All cabling must terminate in an IDF or BDF room on the same floor as the outlet unless building plans, certified and approved by MCC ITS, specify otherwise. Additional specifications for cabling, patch panels and data jacks as per Specification 27 10 00.

c. Habitable Space Provisioning:

- Every habitable space shall be provisioned with a minimum of one data outlet (with 2-Cat.6 Data Jack Inserts) per person planned for the space or one outlet per 60 ft², whichever is greater. If the number of people planned for a space is not known, the 60 ft² guideline must be used.

d. Non-habitable Space Provisioning:

- Every non-habitable space shall be provisioned with one data outlet every 500 ft² minimum of 1 per enclosed space. Exceptions may be granted for unusual circumstances by MCC ITS, in writing.

e. Labeling:

The labeling system shall clearly identify all components of the system: racks, cables, panels, and outlets. The labeling system shall designate the cable's origin and destination. Station identifiers shall match the

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corresponding patch panel port number for each drop. The drops will be in consecutive order whenever possible. They shall increment from left to right then top to bottom on each individual faceplate. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end. Faceplate labels will be the manufacturer's labels provided with the outlet assembly unless otherwise specified.

The labeling scheme shall be as follows:

Interior data drop labels will be in the format of IDF, Rack, Patch Panel, Cable Number (as an example) "2A-1A01". Where "2A" is the IDF or BDF, 1 being Rack 1, "A" is the Patch Panel identifier, and "01" is the port that the drop terminates to in the patch panel.

Exterior data drops at the patch panel shall be labeled with a 3-letter abbreviation describing the intended use in addition to the labeling used for interior drops. For example: 2A-1A01-CAM / 2A-1A01-SPK / 2A-1A01/WAP, where CAM = camera, SPK = speaker, CBP = Code Blue Phone and WAP = wireless access point. Coordinate with MCC ITS representative for other devices not mentioned here.

Cable Wrap labels:

Wrap labels are required within 6 inches of the cable's termination point at both ends. Wrap labels will follow the format listed in this section. The font size will be the largest size that fits the required information but no smaller than 8-point font.

Station labels:

The Station label will follow the format listed in this section. The first patch panel port number will always be the left face plate port and the second patch panel port number will always be the right face plate port. The bottom label will follow the same guidelines when used. When unused the label will be left blank. The font size will be the largest size that fits the required information but no smaller than 10-point font. See Specification 27 10 00.

TR Patch Panel:

The patch panel identifier will be labeled by the installer on the left side of the patch panel in a place that is easily visible. Counting from the top of the rack down, the first installed patch panel will be identified with the Letter A, the second with the Letter B and so on.

The patch panel port label will be in the format listed above. Space limitations will require the label to be in two rows. The font size will be the largest size that fits the required information but no smaller than 8-point font. These labels should be centered and located directly above the port they are labeling or in other manufacturer provided locations for port labels.

Tube Cell Conduit:

The marker plate for tube cell conduit shall be 1 "x 3" in size and must be made of a material able to withstand environmental conditions (e.g., extreme heat, underwater, and dirt/dust). The marker plate shall be placed approximately one foot from the conduit entry and exit.

The marker plate label will be in the format of V-41-D to V-44-D, where V stands for vault and 41 is the previous vault number and 44 is the next vault number. Letter D shows which section of campus the vault is located in.

ABF Tube Cable:

The air blown fiber tube identifier will be labeled by the installer within 6 inches of the tube leaving the TDU. The label shall be four lines with the first being the Tube Cable ID #. The second line shall be the Tube Cable Type (indicating the tube count "7TOX"). The third line shall show the TDU where the Tube originates from. The final line will show the TDU where the Tube will terminate into. All labeling

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information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end.

ABF Individual Fiber Microducts:

The individual microduct identifier will be labeled by the installer within 6 inches of the microduct leaving the TDU. The label shall be three lines with the first being the Tube Cable Type (i.e., "1TGX"). The second line shall show the TDU where the Tube originates from. The final line will show the FTU where the microduct will terminate into. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end.

Fiber Optic Cables:

The individual non-air-blown fiber identifier will be labeled by the installer within 6 inches of the fiber leaving the FTU. The label shall be three lines with the first line showing the number of strands and type of fiber. The second line shall show the distant termination points for this fiber strand (IDF or BDF #). The third line shall show the local termination point for the fiber strand (IDF or BDF #). All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end.

Fiber Enclosures:

The fiber enclosure identifier will be labeled by the installer on the left side of the enclosure in a place that is easily visible. Counting from the top of the rack down, the first installed enclosure will be identified with the alphabetic identifier of A, the second with the B and so on.

At the BDF, the fiber enclosure label will be in the format of "AB-12SM to LLC-AAB", where "AB" are the slots the fiber terminates in, "12SM" is the fiber type and strand count, "LLC-AAB" is the distant end IDF room location, "A" is the fiber enclosure number, and "AB" are the slots the fiber terminates in the distant end. At the IDF enclosure end the labeling will be vice versa of the BDF enclosure end. Space limitations could require the label to be in two rows. The font size will be the largest size that fits the required information but no smaller than 8-point font. These labels should be center justified and located directly in front of the slots they are labeling or in other manufacturer provided locations for labels.

IDF Fiber Enclosures:

The IDF fiber enclosure identifier will be labeled by the installer on the left side of the enclosure in a place that is easily visible. Counting from the top of the rack down, the first installed enclosure will be identified with the alphabetic identifier of A, the second with the B and so on. At the Server Room, the fiber enclosure label will be in the format of "AB-24SM to XXX-AAB", where "AB" are the slots the fiber terminates in, "24SM" is the fiber type and strand count, "XXX" is the BDF Building Name, "AAB" is the distant end BDF FTU location, "A" is the fiber enclosure number, and "AB" are the slots the fiber terminates in the distant end. At the BDF FTU enclosure end the labeling will be vice versa of the IDF enclosure end. Space limitations could require the label to be in two rows. The font size will be the largest size that fits the required information but no smaller than 8-point font. These labels should be center justified and located directly in front of the slots they are labeling or in other manufacturer provided locations for labels.

Vault Lids:

The vault lid identified will be labeled by the installer by welding the label near the center of the vault or maintenance hole covers. If the cover has two parts, the label shall be welded near the center of the north or west part.

The vault lid label will be in the format of “V-###-XXX” or “MH-###-XXX”, where "V" is a vault and "MH" is a maintenance hole. “###” shall be the number assigned based on the master Campus CAD file and "XXX" shall correspond to the section of campus assigned on the master Campus CAD file.

5. WIRELESS ACCESS POINTS -

- a. Data cabling at wireless locations shall be installed above the drop-ceiling grid panels using a Caddy 512A or equivalent mount. They will be terminated in electrical boxes with a single gang reducer ring that are mounted vertical to the ceiling in a north to south orientation. Two blue Cat 6A data cables shall be run directly from the IDF and will be terminated on a Category 6A data jack. The jack will be mounted in a single port surface mount box and will be installed in the electrical box. For new and existing buildings, the contractor will provide a minimum of 20 feet of data cabling service loop above the electrical box.
- b. Electrical boxes used for Wireless Access Point (WAP) installations shall be mounted to the ceiling or secured to equipment that meets local NEC, ANSI/TIA-568-D, and ANSI/TIA-569-D standards. The boxes will be mounted as close to the WAP location as possible to eliminate the use of long patch cords. No cable from the IDF to a connection point may exceed 295 feet.
- c. At each wireless location, connect the WAP to the horizontal cabling using contractor provided patch cords. All patch cables will use appropriate J-hook/supports or dressing.
- d. WAPs that are placed in locations with a hard-lid ceiling will have the cables terminated inside of the electrical box installed in a 1-port surface mount box. The electrical boxes at these locations shall be either 4-inch square boxes with a depth of 3 1/4 inches, or 5-inch square boxes and have a single gang reducer ring that is mounted parallel to the ceiling. Each box must maintain the minimum bend radius of the cable.
- e. WAPs must be installed level horizontally unless otherwise specified and confirmed with MCC ITS representative and be oriented in a consistent manner. Any deviations must be approved by a MCC ITS representative. Wall-mount wireless locations will need to be placed in a faceplate depending on direction of installation and be pre-approved by an MCC ITS representative.
- f. WAP installations shall require the low-voltage contractor to use an MCC ITS provided bracket. This might require the contractor to cut a hole in drop-tile ceiling acoustic tile.
- g. Exterior WAPs will need to be mounted securely to the wall or pole and have 1/2 nonmetallic liquid tight connecting to a weatherproof box or faceplate. Connecting the liquid tight connector to the WAP will need to use Thomas & Betts PG135-50 NTP Thread Adapter or equivalent.
- h. WAPs shall be furnished by the College and installed by the low-volt contractor, with an ITS representative verifying the installation practices and labelling of the WAP.
- i. Exterior WAPs require that the associated shield cover be primed and painted to match the building finish. Use transparent water-based paint as recommended by the manufacturer.

6. WIRELESS ACCESS POINT PLACEMENT AND WIRELESS OVERLAY –

Wireless locations will be specified by consultation with an ITS representative. All wireless designs are subject to client usage expectations and the ability to support the wireless user community without altering new construction, so it is critical that the designs that are provided are adhered to. Below are some general guidelines for WAP placement. Any deviations to these guidelines must be approved by the ITS representative: Any wireless bridge installation which requires rooftop cabling and mounting of wireless bridging hardware, antennae, and masts must be approved by the ITS representative. Design should be based on user density in the area with an assumption of 3 devices per individual needing connection. Data throughput should be sufficient to allow video streaming.

- a. Indoor WAPs shall be designed by way of a heat map using predictive software calculating the areas requiring coverage, user density, infrastructure materials and other RF barriers such as but not limited to windows, heavy doors, cement beams, brick walls, etc. The heat map shall be provided to and approved by an ITS representative.
- b. For outdoor coverage areas, MCC Campus Standards generally require an outdoor WAP every 2500-5500 SQ.FT. This is subject to the infrastructure materials and other RF signal barriers such as trees, buildings, etc. Depending on the areas requiring coverage and infrastructure materials, WAPs may need to be closer. Outdoor coverage should be designed to extend to 100 FT from the building as well as provide coverage for courtyards and parking lots.
- c. Outdoor areas that extend beyond 295' shall utilize a POE extender. Approved products by Gamechanger, Veracity or Leviton OneReach. Coordination with MCC ITS representative required prior to ordering.
- d. In situations where a large number of users will be using the wireless service, the user count may dictate the WAP count and not follow in line with the aforementioned parameters.

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- e. Any wireless bridge installation which requires rooftop cabling and mounting of wireless bridging hardware, antennae and masts may require 3rd party installers.
- f. In situations where the finished ceiling plan is exposed and MCC has specified that wireless hardware and antennae placement must be as limited as possible in order to meet aesthetic requirements of the building, and ITS representative will need to be consulted regarding alternate installation locations.
- g. Installation of WAPs shall not be higher than 15' AFF without prior written authorization from MCC ITS.
- h. WAPs are furnished by MCC and installed by the Communications contractor.

7. EMERGENCY & ESCORT PHONES -

The California Health & Safety code 3.09 requires emergency phones in Elevators and Elevator Lobbies. All elevator lobbies (all floors) shall have a Code Blue LS1000 emergency phone that auto dials MCC PD. The Bldg.'s main elevator lobby must also have a Code Blue LS1000 that auto dials MCC Escort Services. Any Labs that have chemicals shall have a Code Blue LS1000 emergency phone in the adjoining hallway. If there are multiple chemical labs off one hallway the emergency phone can be mounted in a central location. Outdoor locations requiring emergency phones shall utilize Code Blue LS1000. Coordinate current model numbers and locations with MCC ITS and Campus Safety Dept.

8. CABLE TRAYS

All cable trays must be UL rated and approved by MCC ITS prior to their inclusion in specifications.

- a. Supports
Cable trays for horizontal distribution cables will utilize threaded rods of not less than 3/8" in diameter.
- b. Capacity
Cable trays shall be sized for a minimum growth of 50%.
- c. Grounding
Cable trays shall be grounded in accordance TIA-60

9. CABLE INSTALLATION

- a. Copper
Installation to meet or exceed TIA 568.0-E and TIA 569-E.
All terminations are to follow TIA 568B.
Completed installation is to be Certified Category 6/6A using the TIA 568-C.2 testing standard or better. Test documents/results to be supplied to MCC in .PDF and native test equipment format. Completed installation is to be approved by MCC ITS.
- b. Fiber
Installation is to meet or exceed TIA 568.1-E and TIA 569-E. Fiber terminations will be completed using one of the following methods:
 - No epoxy/no polish connectors
 - Factory-terminated pigtails with fusion splicing
 - Single-mode will be terminated in a separate rack-mounted fiber optic enclosure.Completed installation is to be certified using TIA 568.3-E testing standard or better. Test documents/results to be supplied to MCC in .PDF and native test equipment format. Completed installation is to be approved by MCC ITS.

10. PULL AND SPLICE BOXES

a. Location

- Pull boxes must be installed in easily accessible locations. It is not permissible to locate a pull box in a fixed false ceiling unless immediately above a suitably marked access panel.
- All pull boxes shall be placed in a straight section of conduit. Align the corresponding conduits at each end. All boxes shall be properly and adequately secured. They are not to be supported by the conduits entering the box. Install boxes for station cabling immediately above the suspended ceiling.

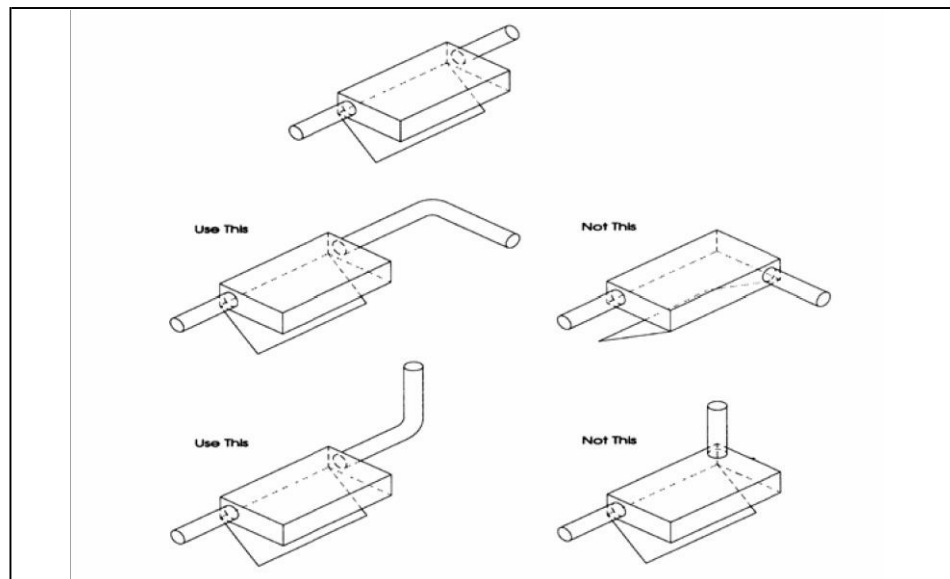
b. Access

- Provide boxes with a suitable cover.

c. Grounding

- If the pull box is comprised of metallic components, it shall be bonded to ground in accordance with the authority having jurisdiction.

PULL BOX CONFIGURATIONS:



SIZING A PULL BOX:

Maximum Trade Size of Conduit (Inches)	Size of Box			For Each Additional Conduit Increase Width (Inches)
	Width	Length	Depth	
1	4	16	3	2
1.25	6	20	3	3
1.5	8	27	4	4
2	8	36	4	5
2.5	10	42	5	6
3	12	48	5	6
3.5	12	54	6	6
4	15	60	8	8

11. PATHWAYS AND COMMUNICATIONS SYSTEMS

CABLE SUPPORT (GENERAL):

The main routing and support systems for communication cables on the Campus are:

1. Cable tray system (Main pathway down corridors)
2. J-hooks and adjustable cable support (bags) (accessible false ceiling areas)
3. Conduit home runs (hard ceiling areas, inaccessible ceiling areas, in-floorboxes, masonry walls). Combined system shall be an overhead distribution method based on the use of a cable tray and J-hook system for routing and an EMT conduit stub-up to the WAO device boxes.

All cable trays shall be divided with a metal divider for shared space. Each building cabling system (800 MHz radio, Access control, CCTV, etc.) shall have their own dedicated secondary J hook cable support from the cable tray.

12. HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

COMMUNICATIONS J-HOOKS:

1. J-hooks shall be spaced at a maximum of 48-inches in the main bundle, 48 to 60-inches apart in the secondary bundles and within 6-inches of an EMT conduit stub-up.
2. Main cable bundle shall be made up of 4-inch saddle bags and supported on a minimum of 3/8-inch rod.
3. Secondary cable bundles shall be made of minimum 2-inch j-hooks with a closer. Support secondary cable bundles with pencil rod. Cable supports shall not exceed 30percent fill ratio. Refer to manufacturer's recommendations. Secondary pathway to 90 off cable tray and contains no more than 25 cables. Location of J-hooks shall be indicated on the Electrical Design and/or Telecommunications drawings.
4. Cables shall not be secured to the J-hook with cable ties or vinyl tape.
5. Contractor to provide drawings indicating Primary and Secondary pathways before installing cable to College's Representative for approval.

13. CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

Installed interior conduits shall:

1. Be installed in the most direct and accessible route possible (parallel to building lines and located in and above accessible hallways).
2. Contain no more than two 90-degree bends in any dimensional plane or exceed 100-feet in length between pulling points or interior pull boxes.
3. A pull box is not to be used in place of a conduit sweep.
4. Stub up to an accessible ceiling area and within 6-inches of a J-hook or cable tray from a device box.
5. Be reamed at both ends and have a plastic bushing installed on each end to prevent damage during cable installation.
6. Have a pull string installed in all conduits with a minimum test rating of 200 lb.
7. Not be installed through areas in which flammable materials may be stored or over and adjacent to boilers, incinerators hot water lines or steam lines.
8. All conduits shall be bonded and grounded in accordance with the CEC and ANSI-J-STD607-C, where applicable.
9. Interior conduits and/or sleeves shall be properly sized in accordance with TIA 569D, Table 4.

CONDUIT BEND RADIUSES

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Internal Diameter	Minimum Bend Radius
2 inches or less	6 times the internal conduit diameter
2 1/4 inches or more	10 times the internal conduit diameter

If an EZ-Path can't be installed, Wall-mounted riser conduits and/or sleeves entering a Telecommunications Space (ER/TR/BDF/IDF) shall have a plastic spillway installed onto the end of the conduit to prevent kinking of the installed cable bundle.

G. GROUNDING

1. REGULATIONS

All conduit and cable tray systems, supports, cabinets, equipment, etc., shall be properly grounded in accordance with the latest edition of the National Electrical Code (NEC), TIA-607-D, and all other applicable codes and regulations.

2. INSTALLATION REQUIREMENTS

Provide all bonding wire and jumpers, grounding bushings, clamps, etc., required for complete grounding. Route ground conductors to provide the shortest, most direct path to the ground electrode system.

3. GROUNDED CONNECTORS

Provide a separate grounding conductor, securely grounded on each side of all conduit and cable trays that do not provide a continuous, metallic path. Size shall be in accordance with the National Electrical Code (NEC). All ground connections will have clean contact surfaces, tinned and sweated while bolting. Avoid splices in bonding or grounding conductors. If splices are required, they must be cad welded. Any grounding or bonding conductor that is run through a metallic conduit should be bonded to the conduit on both ends. Do not use a gas or water pipe as the grounding electrode.

PART II - PRODUCTS AND ACCEPTED MATERIALS

2.0. GENERAL

All material required for a complete installation shall be furnished by the Contractor unless otherwise specified by MCC ITS.

All materials provided by the Contractor must be new, free from defects and must meet MCC 's specifications. A parts list for the approved manufacturers can be found in Specification 27 10 00 Communications Cabling. Substitutions must be authorized in writing by MCC ITS. For projects that require a Request for Proposal, bidders shall submit the make and model of materials that will be used as part of their submittal.

All fixtures and hardware must be installed as per the requirements detailed in this document. No custom items shall be used except as reviewed and approved by MCC ITS. The contractor shall be held financially responsible for any work or re-work required due to improper approval and /or acceptance of that work performed which differs from the construction documents.

All products shall be new and brought to the job site in the original manufacturer's packaging. Electrical components (including innerduct) shall bear the Underwriter's Laboratories label.

All station cables shall be rated for the environment in which they are installed.

The Contractor shall inspect all products and materials prior to installation. Damaged cable or any other components failing to meet specifications shall not be used in installation.

2.1. BACKBOARDS

All backboards required in the TR rooms shall be plywood, 3/4" x 4' x 8' sheets, grade A, treated on one side with fire resistant paint or material, installed with finished side exposed with the bottom of the plywood at 8" above finished floor. When a fire-rated backboard is provided and installed, the official fire-rated stamp shall not be painted over until MCC inspector has approved the product and installation.

2.2. CABLE SPECIFICATIONS

A. WARRANTY

All copper and fiber cabling installations must be covered by an end-to-end manufacturer warranty of no less than 25 years. Vendors must be certified installers of the MCC approved products used for installation. The warranty is required to cover cabling, components, and performance. Parts and labor for replacements must also be included in the warranty.

B. APPROVED CABLING MANUFACTURERS

1. Copper Installation:

Vendors are encouraged to install the Belden Category 6/6A products identified in Specification Section 27 10 00 Communications Cabling, or a pre-approved equal by MCC.

Products selected must meet the requirements detailed in this document.

a. New Building

All copper installations in new buildings on campus will be completed using products from Belden Manufacturer or a pre-approved equal by MCC. All cabling and components will be certified Category 6/6A and will meet all requirements listed in Spec 27 10 00.

b. Existing Building

In cases where vendors install cabling in existing TRs, installers shall use open ports on existing category 6 (New 6A for wireless) patch panels. The warranty requirement listed in Specification 27 10 00 will apply to these installations. This will require vendors to be certified Belden installers for the new components into the existing panels in the IDF. The installer shall adapt the Belden REVConnect jack insert into the existing patch panel. If there are no open ports, not enough ports to complete the job or the existing patch panel is not Category 6, the contractor will use a Belden REVConnect patch panel as specified in Spec 27 10 00 and approved by ITS staff.

2. Fiber Installations:

Vendors are required to install the Sumitomo Electric FutureFlex Air-Blown Fiber optic systems products for Backbone Fiber Optic installation as identified in Specification Section 27 10 00 Communications Cabling. All new or relocated Telecommunication Rooms shall receive a new fiber routed back to the Campus Data Center. Stand counts to be determined by the size of the building that the TR is serving but with a minimum of 12-strands of singlemode fiber and two tube cells.

Products selected from these vendors must meet the requirements detailed in this document.

a. Building to Building:

- All fiber installations for building-to-building interconnects will use air-blown fiber solutions. Contractors shall install components from Sumitomo Electric as specified or a pre-approved equal.

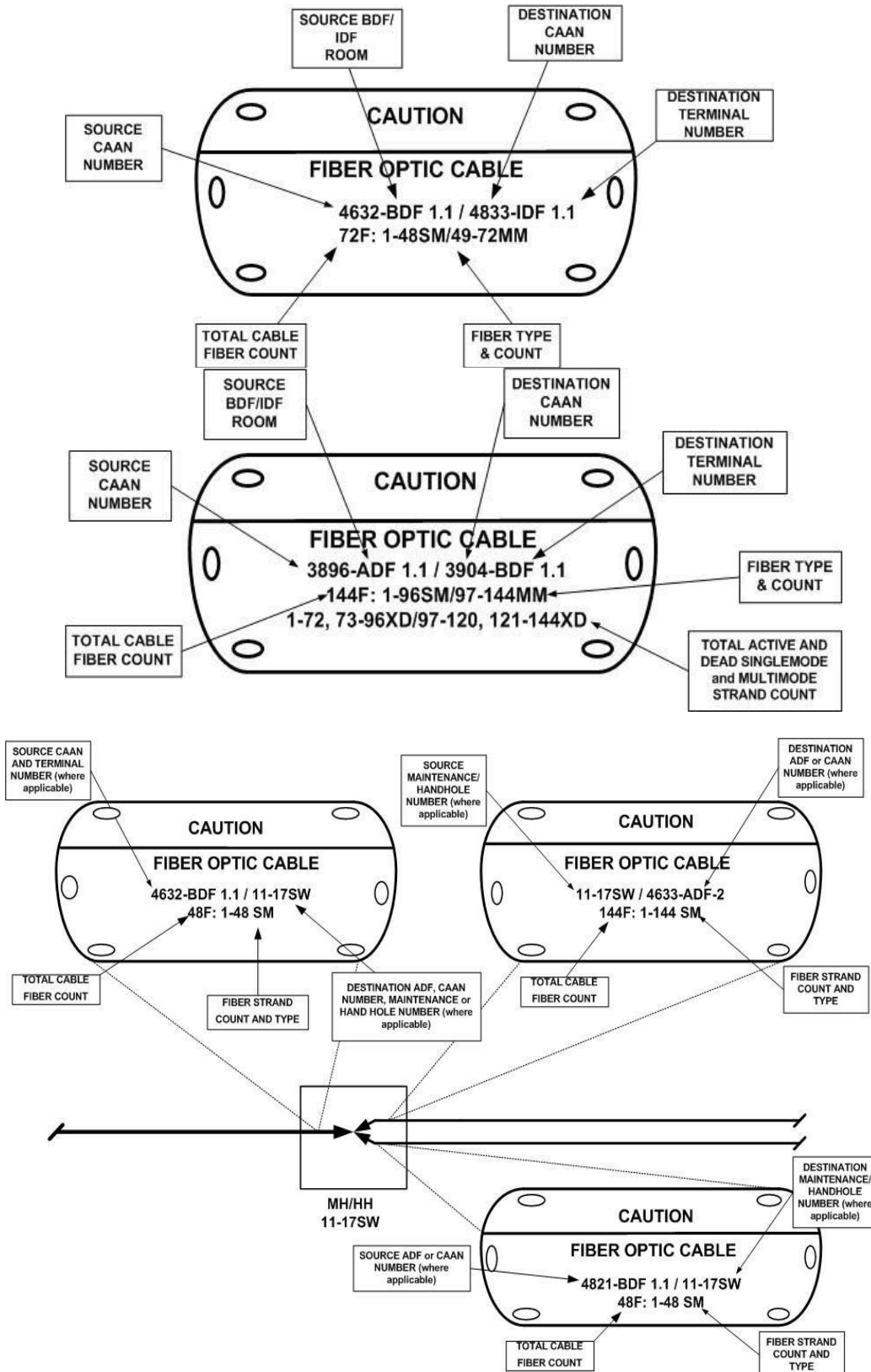
b. New Building:

- All fiber installations for new buildings on campus, including building to building interconnects and BDF to BDF connections will use air-blown fiber solutions. Contractors shall install components from Sumitomo Electric as specified or a pre-approved equal.

c. Existing Building:

- All fiber installations for buildings with existing air-blown fiber infrastructure will be installed using use air-blown fiber solutions. Contractors shall install components from Sumitomo Electric as specified or a pre-approved equal.
- All fiber installations for buildings without existing air-blown fiber infrastructure will be installed using traditional fiber cabling. Contractors shall install components from Belden as specified or a pre-approved equal.

d. Fiber Optic Cable Label Sequence (Cable Tag):



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C. DATA COPPER

All copper data cable for existing buildings will be Category 6 (6A for wireless), 4 pair, UTP (Unshielded Twisted Pair) unless specified differently by MCC ITS, and must meet or exceed TIA and ISO Category 6 requirements. All copper data cable for new buildings will be Category 6 (6A for wireless), 4 pair, UTP (Unshielded Twisted Pair) and must meet or exceed TIA and ISO Category 6 requirements. Only materials from accepted manufacturers in Specification 27 10 00 will be installed. Cables will be rated as plenum or riser based on installation requirements.

D. PATCH CABLES

All patch cables installed by the contractor will be factory terminated and tested to meet requirements stated in Specification 27 10 00.

E. EXTERIOR CABLE

All cables that support devices external of a building such as emergency phones use outdoor-rated Category 6, 4 pair, UTP (Unshielded Twisted Pair) and must meet or exceed TIA and ISO requirements.

F. SINGLE-MODE FIBEROPTIC

All single-mode fiber optic cables must be 8.3/125. All single-mode terminations are to be LC, UPC finish. A 12-strand fiber shall have a 12-port bulkhead a 24-strand fiber shall have a 24-port bulkhead adapter. An adapter panel must be used in the fiber optic enclosure.

G. AIR-BLOWN FIBER COMPONENTS

Vendor to design tube cell count for tube-cell cabling based upon the square footage of the building being served. All designs will be approved by MCC ITS Staff prior to commencement of work on a project-by-project basis. **A minimum of 2 tube cells per IDF to be installed. Actual quantity to be approved by MCC ITS staff.**

All new building IDFs and BDFs will require the installation of fiber distribution boxes. Other locations such as manholes and other splice or junction locations will require watertight fiber distribution splice enclosures as needed.

2.3. DATA TERMINATIONS

A. COPPER DATA COMPONENTS

1. PATCH PANELS

All data patch panels for existing buildings are to be a Belden REVConnect patch panel, (Refer to Spec. 27 10 00) or pre-approved equivalent, that has been viewed, tested and approved by MCC ITS Staff. Equivalent patch panels must accept keystone Category 6 (6A for wireless) jacks, in 2U, 48 port configurations, and must meet or exceed TIA and ISO/IEC Category 6 requirements. They must also be capable of housing keystone data jacks from other manufacturers, and be viewed, tested, and approved by ITS staff.

Every group of 48 must be separated by 2U of open rack space for network equipment. All cabling will route down the rear vertical cable management prior to termination on the patch panel. All terminations are to follow TIA 568B.

The first 48-port patch panel of each TR will be dedicated for Wireless station cabling. These ports will be terminated on Belden REVConnect Category 6A patch panel.

2. DATA JACKS

All data jacks for existing buildings shall be modular, unshielded, 4-pair, 8P8C, Category 6, black (Cat 6A blue for Wireless) unless otherwise specified and must meet or exceed TIA and ISO/IEC Category 6 requirements. Jacks shall be Belden REVConnect Category 6 (6A for Wireless).

All data jacks for new buildings shall be modular, unshielded, 4-pair, 8P8C, Category 6, (Cat 6A for Wireless) unless otherwise specified, and must meet or exceed TIA and ISO/IEC Category 6 requirements.

All terminations are to follow TIA 568B.

3. FACEPLATES

All faceplates shall be 2 or 4 port stainless steel, single gang, low profile, with a window for labels. All unused ports must be covered with a blank insert.

B. FIBER OPTIC

1. Terminations

Terminations will be completed with one of the two following methods:

Factory-terminated pigtails with fusion splicing or Fusion Splice-on connectors

Fusion splices will be protected in splice cases or other suitable enclosures.

2. Connectors

Single-mode fiber is to be terminated with LC style connectors, UPC.

3. Fiber enclosures

Fiber optic enclosures for inter-building traditional fiber optic installations are based on Specification 27 10 00, Part 2.9 for BDF and IDF racks. Sizing of enclosures will be based on total strand counts.

Fiber optic enclosures for building-to-building air-blown fiber optic installations are based on Specification 27 10 00 for BDF and IDF racks. Sizing of enclosures will be based on total strand counts. Equivalent enclosures can be approved by ITS on a case-by-case basis.

4. Fiber Adapter Panels

12 strand Single-mode fiber will terminate in 12 strand adapter panel and a 24 strand Single-Mode fiber will terminate in a 24 adapter panels.

2.4. DATA EQUIPMENT RACKS

All racks are to be two post, open frame, tapped holes, white, manufactured by CPI or pre-approved equal. Substitutions must be authorized in writing by MCC ITS.

2.5. CABLE TRAYS

All cable trays for distribution of data cables within a building are to be a minimum of 18" wide by 4" deep, solid trough or ladder and will be approved by MCC ITS.

2.6. EXCEPTIONS

Due to unique constraints and requirements of existing TRs, exceptions may be authorized for existing buildings only with approval of MCC ITS and shall be granted in writing.

3. PART III - EXECUTION

The College may have drawings detailing existing cable runs, terminal cabinets/closets, risers, etc. Copies may be obtained from MCC ITS to facilitate the requirements of Part III - Execution.

Unless otherwise expressly provided in the Contract, any provisions of the standard specifications, which require the College to inspect certain material or work, shall mean that the College has the option, rather than the obligation, to do so. Any warranty or guarantee provisions contained in the Contractors'/Vendors' standard specifications shall be of no effect and the warranty and guarantee provisions, if any, of the Contract shall apply.

3.1. DEMOLITION

A. COORDINATION WITH COLLEGE OPERATIONS

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No telecommunication or data jacks, cabling terminals, or other hardware will be moved, disconnected, or removed without prior approval of MCC ITS. Coordination of demolition activities with the departments will be strictly enforced to minimize service disruptions.

B. WORK TO BE PERFORMED BY OWNER

Upon notification by Contractor, MCC ITS will dispatch a technician to the requested work location. The technician will determine if the telecommunications or data facilities hardware to be moved or removed are in service (hot) or out of service (dead). If station cabling is dead the technician will take the necessary actions to render the facilities dead. Under NO circumstances will removal of telecommunications or data facilities begin until MCC ITS has ensured that services are dead.

3.2. INSTALLATION

A. REGULATIONS

All work and materials will comply with all federal and State laws, municipal ordinances, codes, regulations and direction of inspectors appointed by proper authorities having jurisdiction.

If there are violations of codes and/or industry standards, the contractor will correct the deficiency at no cost to the College.

Working conditions must meet the industry standards for safety and work procedures, and protection of property established by prevailing rules, regulations, codes, and ordinances.

B. DISPOSAL OF SURFACE-MOUNT RACEWAY

Surface mount raceway that has been vacated, or otherwise determined not required, will be removed after all cabling has been properly removed.

3.3. EXCAVATION

No trenching will commence until MCC Facilities/Construction Department and MCC ITS grants approval. The College may have drawings of existing underground utilities to assist the Contractor in locating all underground utilities. All Contractors are to contact Underground Service Alert of Southern California (DigAlert) by Calling 811 or at www.digalert.org. All lines damaged by Contractor will be repaired at Contractor's expense.

Asphalt and concrete pavement shall be sawed or cut to a depth necessary to bring about a straight-line break parallel to the sides of the trench, so as not to disturb the adjoining pavement.

All underground construction work, during progress and after completion, shall conform truly to lines and grades.

If the trench is excavated to a greater depth than that given, the Contractor shall, at his own expense, bring such excavation to required grade with such material as directed, notwithstanding that it may be necessary to bring such material from other localities or to purchase suitable materials.

The material excavated shall be deposited along the side of the trench in such a manner as to create the least inconvenience possible.

Contractor shall not obstruct the gutter of any street or driveways but shall use all proper means to provide the free passage of surface water along the gutters into storm water inlets. Contractor shall provide channels where required.

Special care shall be taken to always keep all fire hydrants and gate valves on water mains accessible. Fire lanes are to be kept open.

Wherever required, sides of the trench shall be sheeted and braced in strict accordance with the rules, orders and regulations of the State, County, and the City. Trenches shall be barricaded.

Grass will be replaced by a method approved by the College.

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Bricks, blocks, and other debris removed from trenches will not be used as fill for trenches.

A. QUALITY ASSURANCE

Workmanship and neat appearance shall be as important as the mechanical and electrical efficiency of the system. All testing and clean-up shall be completed to the satisfaction of MCC ITS before sign-off. This includes, but is not limited to, cable testing, proper labeling, debris removal, and proper cable bundling and routing.

B. DAMAGE OF EXISTING FACILITIES

The Contractors shall be responsible for replacing, restoring, or bringing to at least original condition any damage to floors, ceilings, walls, furniture, grounds, pavement, etc., caused by its personnel and operations. Any damage or disfiguration will be restored at the Contractor's expense.

C. COORDINATION

Contractor is responsible for insuring minimal disruption of existing television, telemetry, telephone and data communications facilities and networks.

Outages shall be scheduled only with permission from MCC ITS at its convenience. All work areas shall be cleared of all litter, and properly disposed of by Contractor on a daily basis.

At its own expense, Contractor shall erect temporary fencing where required or deemed necessary by College personnel, or where deemed necessary by the Contractor for securing materials.

Contractors shall provide all necessary temporary equipment and material, shall maintain them in a safe and adequate manner, and shall remove them immediately upon completion of work requiring their presence.

D. CABLE SUPPORT AND ANCHORS

All cables, wires and equipment will be firmly anchored. Fasteners and supports shall be adequate to support loads with ample safety factors.

All data cables installed without conduit in plenum spaces will be secured using j-hooks or other ITS approved mounting hardware.

E. FIRESTOP SYSTEMS

A firestop system is comprised of an item or items penetrating a fire rated structure, the opening in the structure, the sealing materials, and assembly of the materials used to seal the penetrated structure. Firestop systems comprise an effective block for fire, heat, vapor, and pressurized water stream. All penetrations through fire rated building structures (walls and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating items i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly fire stopped using state approved fire-resistant materials installed in accordance with the manufacturer's tested methods. All penetrations through fire rated surfaces shall comply with the following:

1. ASTM E 84: Standard Test Methods for Surface Burning Characteristics of Building Materials
2. ASTM E 119: Methods of Fire Tests of Building Construction Materials
3. ASTM E 814: Standard Method of Fire Tests of Through-Penetration Firestops
4. ASTM C 719: Adhesion and Cohesion of Elastomeric Joint Sealants under Cyclic Movement
5. ASTM C 920: Standard Specification of Elastomeric Joint Sealants
6. UL 263: Fire Tests of Building Construction Materials
7. UL 723: Surface Burning Characteristics of Building Materials
8. UL 1479: Fire Tests of Through Penetration Firestops
9. UL 2079: Standard for Fire Tests of Joint Systems

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F. CONDUIT

1. Conduit shall be Electrical Metallic Tubing produced in accordance with ANSI C80.3 standard and run in the most direct route practical.
2. Conduit runs containing more than two 90-degree bends, or a reverse (180 degree) bend require a pullbox.
3. All offsets shall be considered equivalent to a 90-degree bend.
4. Sections of conduit longer than 100 ft. require a pull box.
5. Conduit bend radius will be a standard ten times the outside diameter of conduit unless otherwise approved by MCC ITS.
6. Conduits entering the IDF through the wall shall be reamed or bushed and terminated not more than 4 inches from the wall surface.
7. Conduits entering the IDF from below shall be terminated 4 inches above finished floor.
8. Conduit runs for distribution cables (both horizontal and vertical), except station outlets, shall be not less than 4" in diameter. They will be equipped with a plastic or nylon number 12 or larger pull line that is rated at 800- 1b. test minimum.
9. Conduit installed for data and/or voice cabling may not be shared with any other cable.
10. All conduit runs for station outlets shall be not less than 1" in diameter. They will be equipped with a plastic or nylon number 12 or larger pull line that is rated at 800-1b. test minimum.
11. After installation, all conduits shall be clean, dry, unobstructed, capped for protection and labeled with their destination (by room number) for identification.
12. Allowable fill capacity is 40% or as defined by the National Electric Code, whichever is lower.
13. Conduit runs for horizontal distribution cables, utilizing the trapeze hanger method to support the conduits, shall utilize threaded rods of not less than 3/8" in diameter.
14. Conduit shall not block access to existing services.
15. All junction boxes will maintain the minimum bend radius for the cable being installed. Special consideration should be taken concerning the use of Category 6/6A cabling, data termination jacks, and the minimum bend radius with required twelve (12) inch minimum excess cable at each outlet.
16. Pull boxes will be installed in position and relationship to adjoining work, securely anchored to supporting structure, sealed and finished, and in a manner, which produces a level box with square, plumb, and straight edges.
17. All junction box covers shall be labeled with Communication when communication cabling is inside of junction box.

Maximum Fill Requirements for Riser Cable

*Internal diameters are taken from the manufacturing standard for electric metallic tubing and rigid metal conduit.

Conduit		Area of Conduit		
Trade Size (Inches)	Internal Diameter* (Inches)	Maximum Recommended Fill		
		1 Cable 53 percent Fill (sq. in.)	2 Cables 31 percent Fill (sq. in.)	3 Cables 40 percent Fill (sq. in.)
1	1.05	0.46	0.27	0.35
1¼	1.38	0.79	0.46	0.60
1½	1.61	1.08	0.63	0.81
2	2.07	1.78	1.04	1.34
2½	2.47	3.11	1.82	2.34
3	3.07	4.69	2.74	3.54
3½	3.55	6.12	3.58	4.62
4	4.03	7.82	4.57	5.90

Maximum Allowable Conduit Fill Based Upon 40% Allowable Fill

Trade Size **	Inside Diam. inch								
		5.6 mm (0.22)	6.1 mm (0.24)	7mm (0.28) *	7.9 mm (0.31)	9.5 mm (0.35)	13.5 mm (0.53)	15.8 mm (0.62)	17.8 mm (0.70)
1	1.04	10	9	6	5	3	0	0	0
1-1/4	1.38	17	16	11	9	6	1	1	1
1-1/2	1.61	23	21	15	12	8	2	1	1
2	2.06	39	36	24	20	14	4	3	2
2-1/2	2.46	56	51	35	29	20	6	3	3
3	3.06	86	79	54	45	30	7	6	6
3-1/2	3.54	115	106	72	60	41	12	7	6
4	4.02	149	136	93	78	52	14	12	7
typ 4-pair CAT5E cable									
typ 4-pair CAT6 (w/o divider) cable									
typ 4-pair CAT6A (w/ divider) or 4-pair ScTP									
typ 12-pair CAT3 unshielded or RG6 Quad shielded									
typ 25-pair CAT3 unshielded cable									
typ 50-pair CAT3 unshielded cable									
typ 50-pair CAT3 shielded ARMM cable									
typ 100-pair CAT3 unshielded cable									

G. CABLE INSTALLATION

1. All cables shall be installed free of kinks. A kink is defined as a violation of the manufacturer's specified Minimum Bend Radius for each type of cable. Cable shall not be formed into a condition that causes the outside sheath to wrinkle.
2. Any cable to be placed through an electrical room or any other potentially hazardous condition shall be placed in conduit.
3. All cables will be secured to the backboard in such a manner as to allow cross connections to be made without crossing over any cables.
4. All data outlets will have a minimum of 10' of cable stored above the ceiling at each drop location after the cable has been terminated.
5. All data cabling will have a service loop with a minimum of 10 feet of data cabling that will be placed on the BDF/IDF ladder rack.
6. Where installation of conduit is not required, plenum cable will be used. Cables are not permitted to lie atop a lay-in ceiling or simply drape over pipe and ductwork; appropriate J-hook/supports or dressing will be used.
7. All cabling in an open ceiling and/or open-plenum space will be run in conduit or cable tray.
8. Cable supports are to be anchored in accordance with TIA 569-D and NEC.
9. Cable pulled in a cable tray with existing cable should not be pulled where stress would be applied to the existing cable.
10. All cables are to be terminated at both ends, tested, labeled and ready to provide service to and within the building.
11. Hook and loop tape are the only approved product for bundling cable. Tie-wraps shall not be used to bundle cable.
12. Installation to meet or exceed TIA 568.0-E and TIA 569-E. MCC ITS must approve completed installation.

H. CABLE TESTING

All cables and termination hardware shall be 100% tested for defects in installation and to verify cable performance under installed conditions. The contractor, prior to system acceptance, shall verify all conductors of each installed cable. Any defect in the cabling system installation including but not limited to cable, connectors, feed-through couplers, patch panels, and connector blocks shall be repaired or replaced to ensure 100% usable conductors in all cables installed.

1. Copper 4-Pair Cable

All Data cables shall be tested in accordance with TIA-568-C.2 Balanced Twisted-Pair

Telecommunications Cabling and Components Standard or better and best industry practices. If any of these are in conflict, the Contractor shall be responsible for bringing any discrepancies to the attention of MCC ITS. All results shall be PASS. Any *PASS test results will require troubleshooting and repair of the cable in question to achieve a PASS test result.

a. Testing

Each cable shall be tested for wire map, length, and performance. The data cables shall be bidirectional tested using a TIA 1152 level III or better cable analyzer. The cable analyzer shall be within the calibration period recommended by the manufacturer. Manufacturer to be Fluke DSX-8000 or MCC approved equal.

- Wire Map

Each pair of installed cable shall be tested for continuity, opens, shorts, pair reversals, split pairs, transposed pairs, and any other miss-wiring. The test shall be recorded as pass/fail as indicated by the test set in accordance with the manufacturers recommended procedures and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable retested prior to final acceptance.

MiraCosta College- Division 27 Campus Communications Design and Installation

- Length

Each installed cable shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the TIA-568.1-E Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the longest pair length shall be recorded as the length for the cable.

- Performance Verification

Category 6/6A data cable shall be performance verified using an automated test set as required by manufacturer for 25-year warranty purposes. This test set shall be capable of testing for the continuity and length parameters defined above, and provide results for the following tests:

1. Return Loss
2. Insertion Loss
3. NEXT (Near-End Crosstalk)
4. PSNEXT (Power Sum Near-End Crosstalk)
5. FEXT (Far End Crosstalk) Loss
6. ACRF (Attenuation to Crosstalk Ratio Far-End)
7. PSACRF (Power Sum Attenuation to Crosstalk Ratio Far-End)
8. TCL (Transverse Conversion Loss) — recorded for information only
9. ELTCTL (Equal Level Transverse Conversion Transfer Loss) — recorded for information only
10. Coupling Attenuation
11. Propagation Delay
12. Propagation Delay Skew
13. PSANEXT (Power Sum Alien Crosstalk) Loss
14. Average PSANEXT Loss
15. PSAFEXT (Power Sum Alien Far-End Crosstalk) Loss (connecting hardware only)
16. PSAACRF (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
17. Average PSAACRF
18. ACRN (Attenuation to Crosstalk Ratio Near-End) — recorded for information only
19. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End) — recorded for information only
20. DC Loop Resistance
21. DC Resistance Unbalance (Channel Test)

Equipment:

Test results shall be automatically evaluated by the equipment, using the most up-to-date criteria from the TIA 568.1-E Standard, and the result shown as pass/fail. All test results to be provided to MCC ITS in .PDF format via USB drive and native format prior to acceptance of completed project. All test results must be labeled with the specific data cable that was tested by its identifier on the patch panel.

2. Fiber Optic

Test results shall be automatically evaluated by the equipment, using the most up-to-date criteria from the TIA 568.3-E Standard, and the result shown as pass/fail. The test results shall include all tests performed and the actual test result achieved. All test results to be provided to the MCC ITS in .PDF format prior to acceptance of completed project. All test results must be labeled with the specific data cable that was tested by its identifier on the patch panel.

Test evaluation for the panel to panel (backbone) shall be based on the values set forth in the TIA-568.3-E, Optical Fiber Cabling Components.

Attenuation testing shall be performed with a stable launch condition using two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place after calibration and the power meter moved to the far end to take measurements.

The expected results for each cable (or group of cables of the same nominal length) shall be calculated before the start of testing and recorded in a space provided on the Contractor's test matrix. Each strand of fiber in the respective cable shall be evaluated against this target number. Any fibers that exceed this number by more than -0.5dB shall be repaired or replaced at the installers' cost.

a. Singlemode:

Singlemode optical fiber attenuation shall be measured at 1310 nm and 1550 nm using a laser light source and power meter. Tests shall be performed at both wavelengths in one direction on each strand of fiber. The set-up and test shall be performed in accordance with TIA-526-7-A Standard, Method IA. Two-meter patch cords shall be used as test references and for the actual test. This test method utilizes a one-jumper reference, two-jumper test to estimate the actual link loss of the installed cable plus two patch cords. Single-mode fiber optic cable must meet or exceed the following limits:

MAXIMUM LOSS MEASUREMENTS

Maximum Loss Measurements for Installed Fiber Optic Cables	
Mated Connector Loss:	0.5 dB per mated pair
Connector Loss:	0.5 dB per connector
Splice Loss: Fusion Multimode	0.15 dB
Fusion Single-mode	0.06 dB
Fiber loss: Multimode (Legacy)	3.5 dB/km @ 850 nm 1.0 dB/km @ 1300 nm
Fiber loss: Single mode	0.4 dB/km @ 1310 nm (Outside Plant Cable) 0.3 dB/km @ 1550 nm (Outside Plant Cable) 1.0 dB/km @ 1310 nm (Inside Plant Cable) 0.75 dB/km @ 1550 nm (Inside Plant Cable)

3. OTDR

Each cable shall be tested with an Optical Time Domain Reflectometer (OTDR) to verify installed cable length and splice losses. The OTDR measurements for length shall be performed in accordance with TIA 568.3-E. The measurements to determine splice loss shall be performed in accordance with manufacturer's recommendations and best industry practices.

4. As-Built

All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. The As-built drawings shall clearly identify the patch panel label and its corresponding station side location. As-builts will be created from the latest digital architectural drawings, to most closely resemble exact building conditions, as possible. Hand drawings are not acceptable. As-builts must be provided in both .PDF and CAD format. In the CAD format, two layers shall be required for documentation. The first layer shall MiraCosta College- Division 27 Campus Communications Design and Installation

document the cable path from the station to the TR. It shall show the conduit, junction boxes, cable tray, etc. locations used for the cabling. Any cable path in conduits does not need to be documented. The second layer shall document the endpoints of the cabling (station and TR) with the cable labels. Upon acceptance of contract, vendor will be required to provide an acceptable timeline for provision of As-Built drawings. An acceptable timeline shall be verified by MCC ITS. Ample time must be allocated for verification of As-builts & test results and subsequent corrected versions of those documents. Network equipment will not be provisioned until this documentation is provided. A 24" x 36" printed and laminated copy of the as-builts will be posted in each BDF/IDF showing the areas being served from that room.

I. GROUND TESTING

Two-point ground and continuity testing will be performed to determine if there is an acceptable maximum level of resistance between any point in the telecommunications bonding and grounding system and the building's electrical grounding electrode system.

- a. Prior to performing a two-point test, a visual inspection shall be performed to verify the bonding and grounding system is installed according to TIA-607-D-1 guidelines.
- b. For the test to be valid it must be done prior to the installation of the telecommunications equipment.
- c. The recommended maximum value for resistance between any point is 100 milliohms.
- d. The following areas will be tested:
- e. PBB/SBB to the electrical ground from each TR.
- f. PBB/SBB to the building steel (if present).
- g. PBB to SBB
- h. Building steel (if present) to the electrical ground.
- i. All test results are to be provided to MCC ITS in .PDF format prior to acceptance of completed project.

Figure 1 – Typical BDF

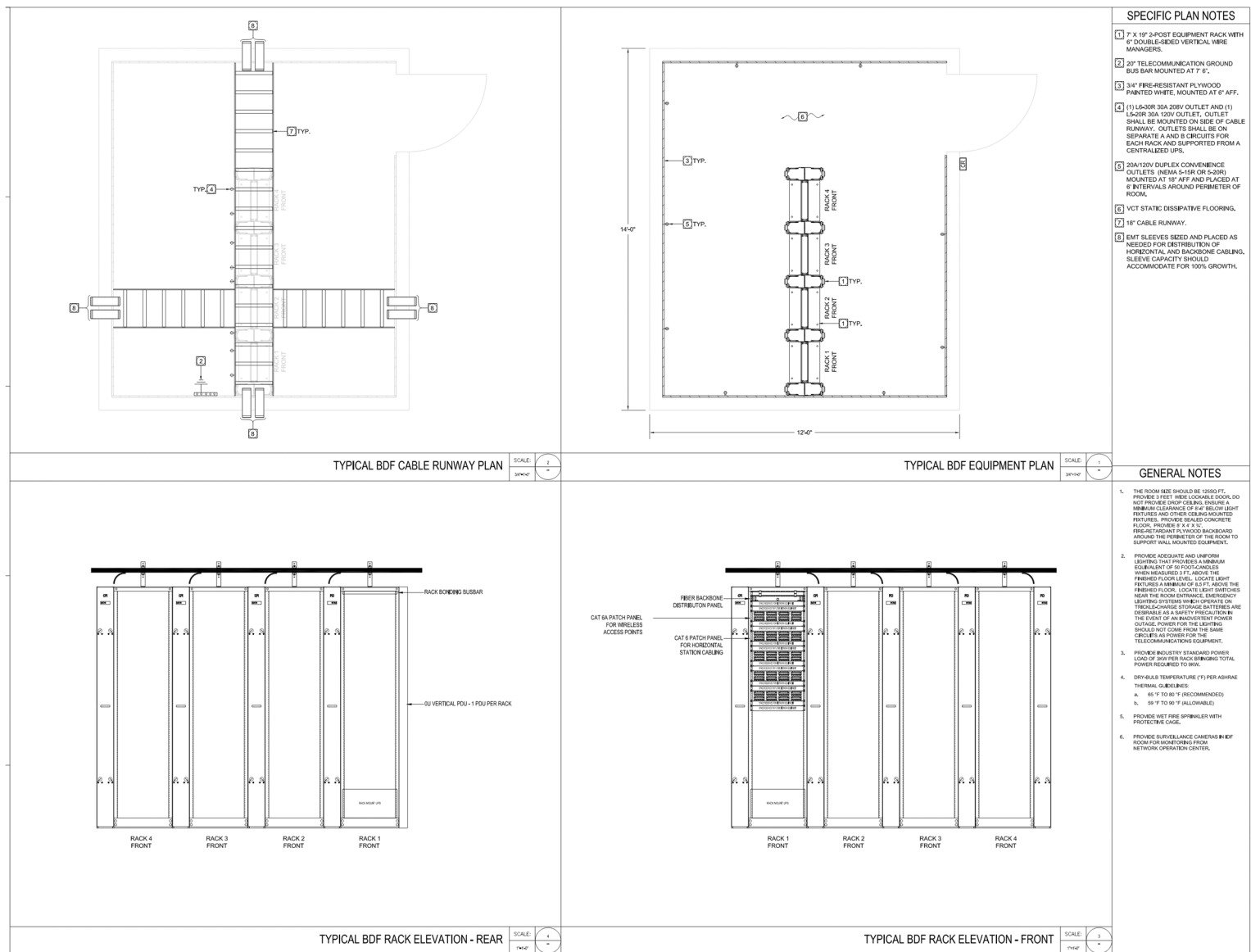
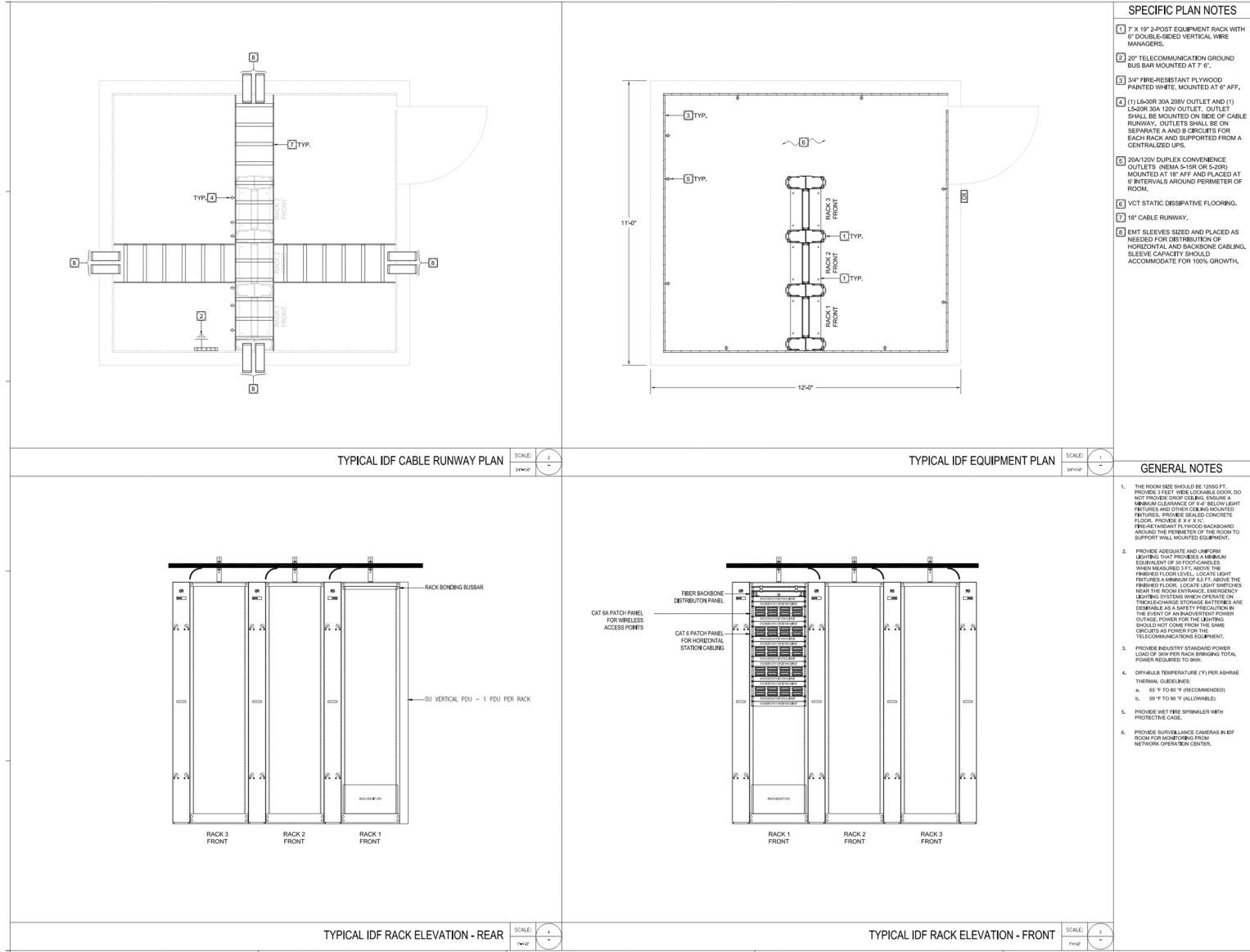
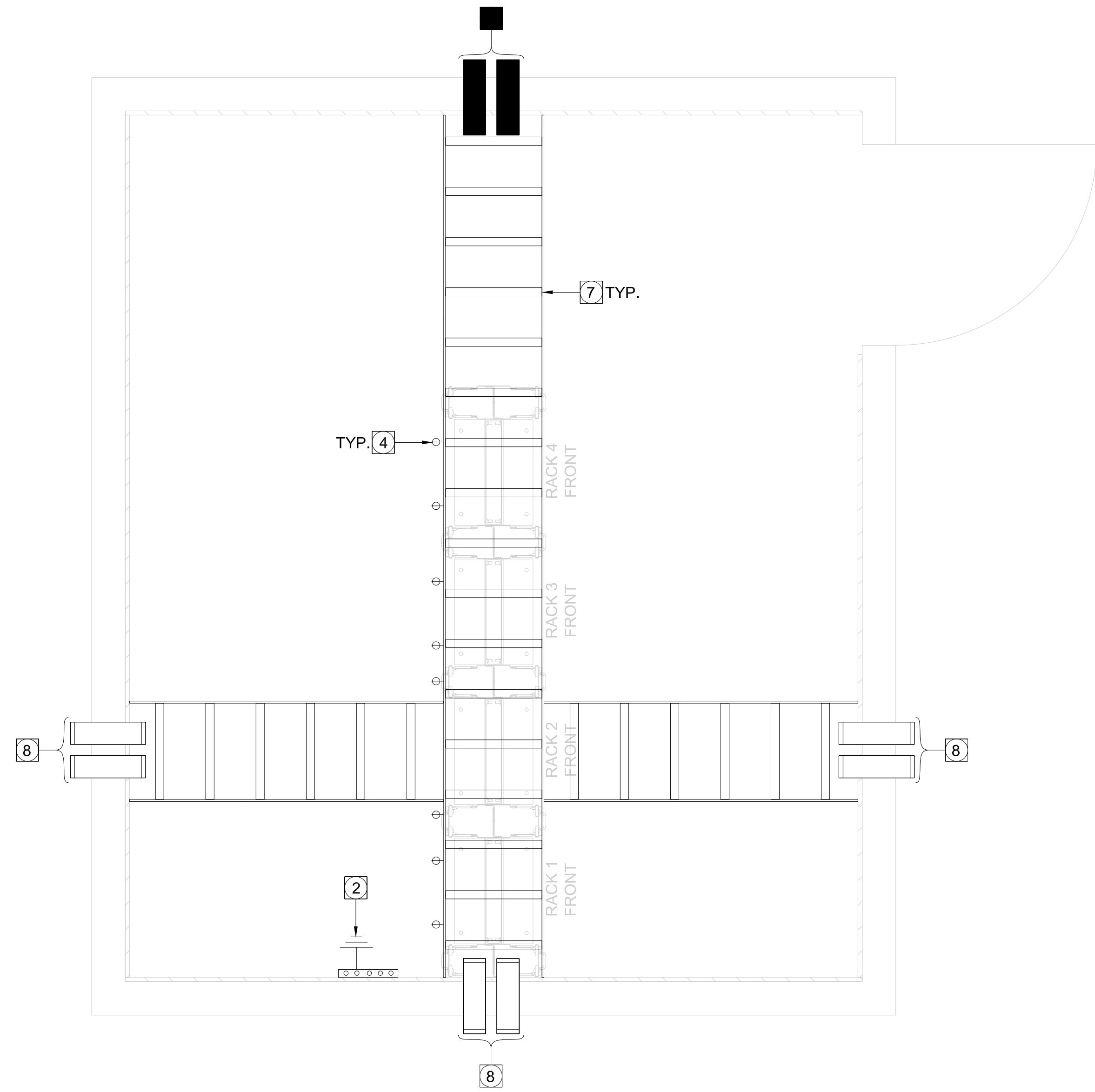


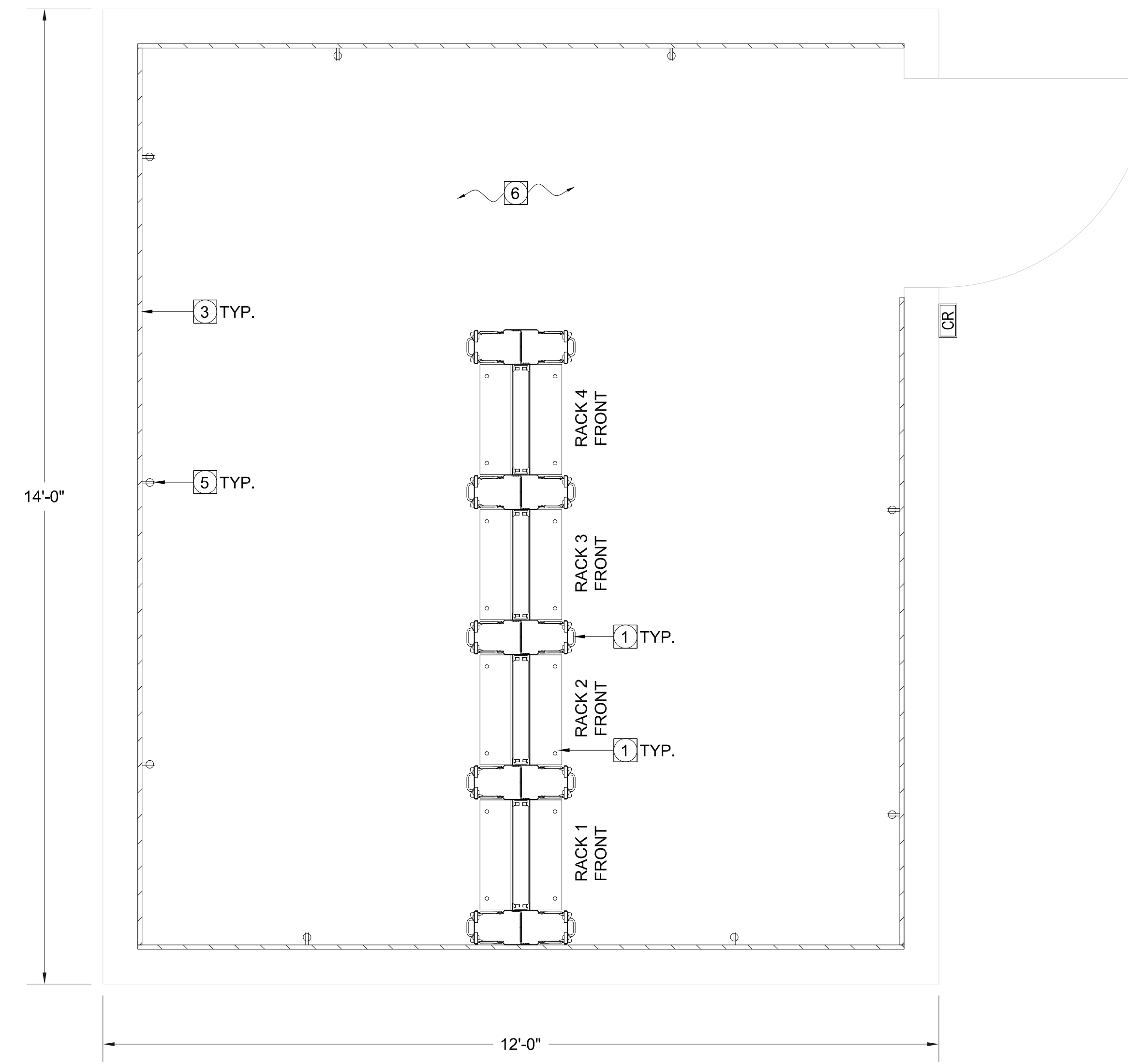
Figure 2 – Typical IDF





TYPICAL BDF CABLE RUNWAY PLAN

SCALE: 2
 3/4"=1'-0"



TYPICAL BDF EQUIPMENT PLAN

SCALE: 1
 3/4"=1'-0"

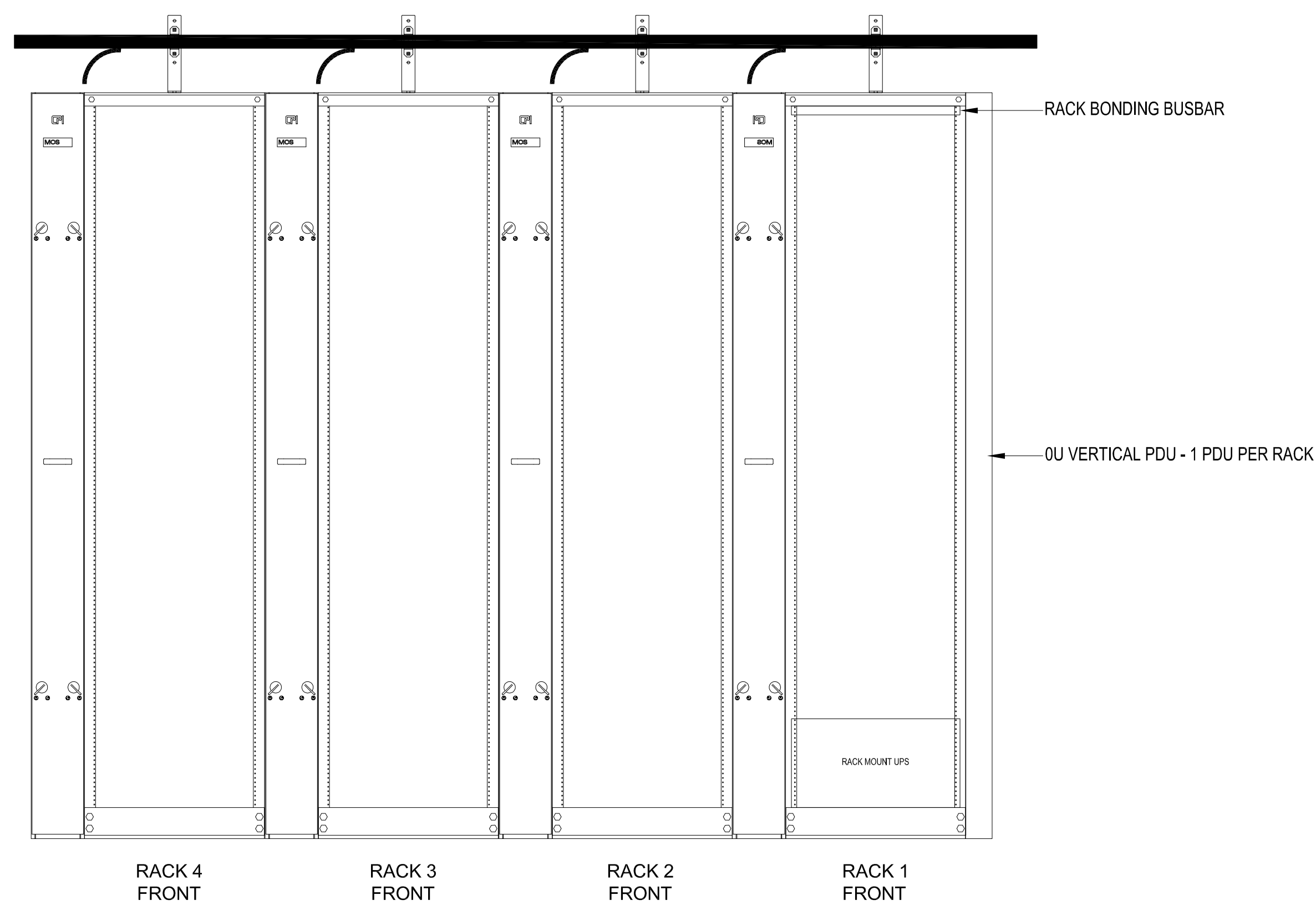
SPECIFIC PLAN NOTES

- 1 7' X 19" 2-POST EQUIPMENT RACK WITH 6" DOUBLE-SIDED VERTICAL WIRE MANAGERS.
- 2 20" TELECOMMUNICATION GROUND BUS BAR MOUNTED AT 7' 6".
- 3 3/4" FIRE-RESISTANT PLYWOOD PAINTED WHITE, MOUNTED AT 6" AFF.
- 4 (1) L6-30R 30A 208V OUTLET AND (1) L5-20R 30A 120V OUTLET. OUTLET SHALL BE MOUNTED ON SIDE OF CABLE RUNWAY. OUTLETS SHALL BE ON SEPARATE A AND B CIRCUITS FOR EACH RACK AND SUPPORTED FROM A CENTRALIZED UPS.
- 5 20A/120V DUPLEX CONVENIENCE OUTLETS (NEMA 5-15R OR 5-20R) MOUNTED AT 18" AFF AND PLACED AT 6' INTERVALS AROUND PERIMETER OF ROOM.
- 6 VCT STATIC DISSIPATIVE FLOORING.
- 7 18" CABLE RUNWAY.
- 8 EMT SLEEVES SIZED AND PLACED AS NEEDED FOR DISTRIBUTION OF HORIZONTAL AND BACKBONE CABLING. SLEEVE CAPACITY SHOULD ACCOMMODATE FOR 100% GROWTH.

GENERAL NOTES

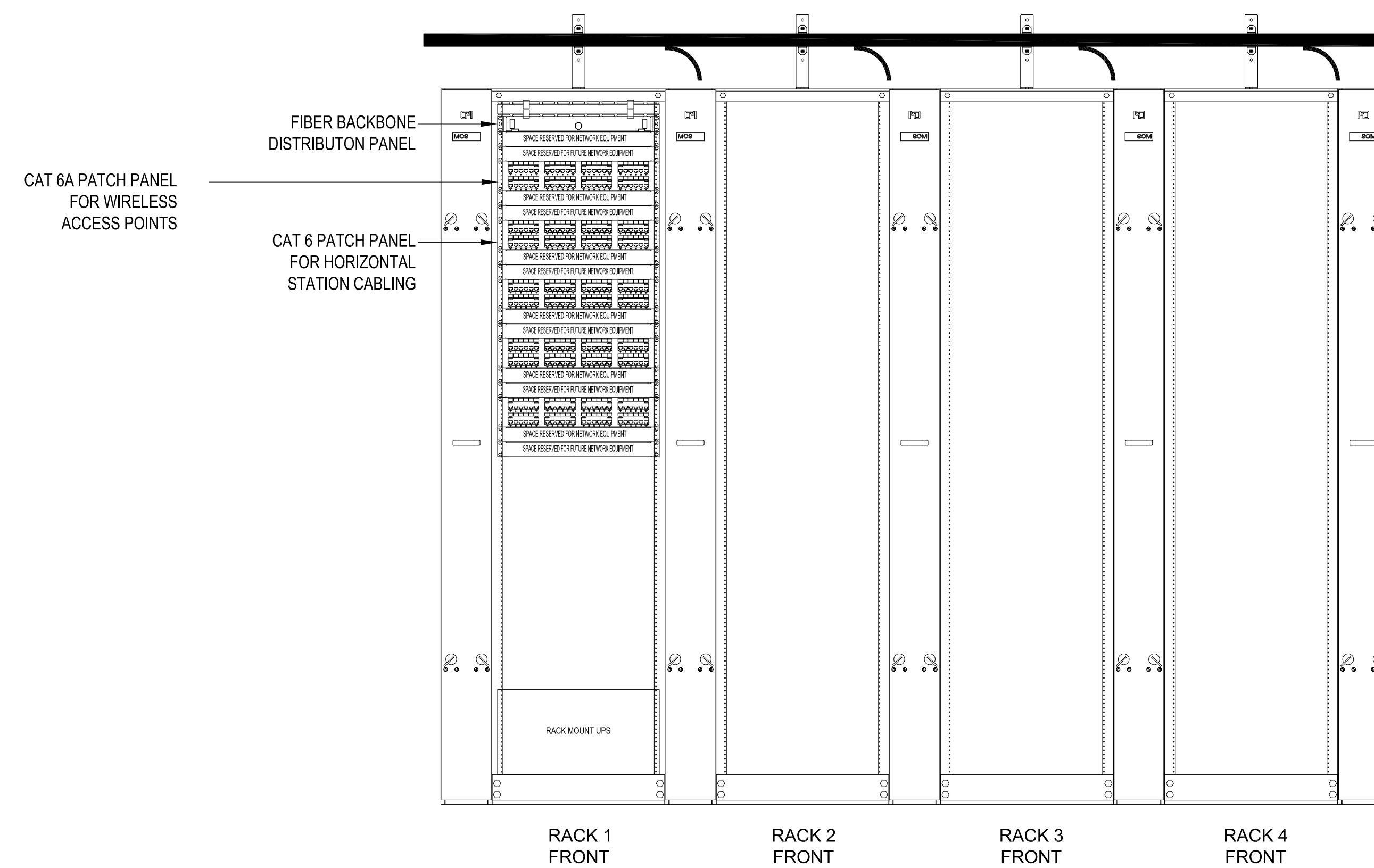
1. THE ROOM SIZE SHOULD BE 125SQ FT. PROVIDE 3 FEET WIDE LOCKABLE DOOR. DO NOT PROVIDE DROP CEILING. ENSURE A MINIMUM CLEARANCE OF 8'-6" BELOW LIGHT FIXTURES AND OTHER CEILING MOUNTED FIXTURES. PROVIDE SEALED CONCRETE FLOOR. PROVIDE 8' X 4' X 3/4" FIRE-RETARDANT PLYWOOD BACKBOARD AROUND THE PERIMETER OF THE ROOM TO SUPPORT WALL MOUNTED EQUIPMENT.
2. PROVIDE ADEQUATE AND UNIFORM LIGHTING THAT PROVIDES A MINIMUM EQUIVALENT OF 50 FOOT-CANDELES WHEN MEASURED 3 FT. ABOVE THE FINISHED FLOOR LEVEL. LOCATE LIGHT FIXTURES A MINIMUM OF 8.5 FT. ABOVE THE FINISHED FLOOR. LOCATE LIGHT SWITCHES NEAR THE ROOM ENTRANCE. EMERGENCY LIGHTING SYSTEMS WHICH OPERATE ON TRICKLE-CHARGE STORAGE BATTERIES ARE DESIRABLE AS A SAFETY PRECAUTION IN THE EVENT OF AN INADVERTENT POWER OUTAGE. POWER FOR THE LIGHTING SHOULD NOT COME FROM THE SAME CIRCUITS AS POWER FOR THE TELECOMMUNICATIONS EQUIPMENT.
3. PROVIDE INDUSTRY STANDARD POWER LOAD OF 3KW PER RACK BRINGING TOTAL POWER REQUIRED TO 9KW.
4. DRY-BULB TEMPERATURE (°F) PER ASHRAE THERMAL GUIDELINES:
 - a. 65 °F TO 80 °F (RECOMMENDED)
 - b. 59 °F TO 90 °F (ALLOWABLE)
5. PROVIDE WET FIRE SPRINKLER WITH PROTECTIVE CAGE.
6. PROVIDE SURVEILLANCE CAMERAS IN IDF ROOM FOR MONITORING FROM NETWORK OPERATION CENTER.

PROJECT: _____
 CONDUIT: _____
 NOT FOR CONSTRUCTION



TYPICAL BDF RACK ELEVATION - REAR

SCALE: 4
 1"=1'-0"



TYPICAL BDF RACK ELEVATION - FRONT

SCALE: 3
 1"=1'-0"

MIRACOSTA COLLEGE
 1 BARNARD DR,
 OCEANSIDE, CA 92056

REVISIONS

NO.	DATE	DESCRIPTION

ISSUES

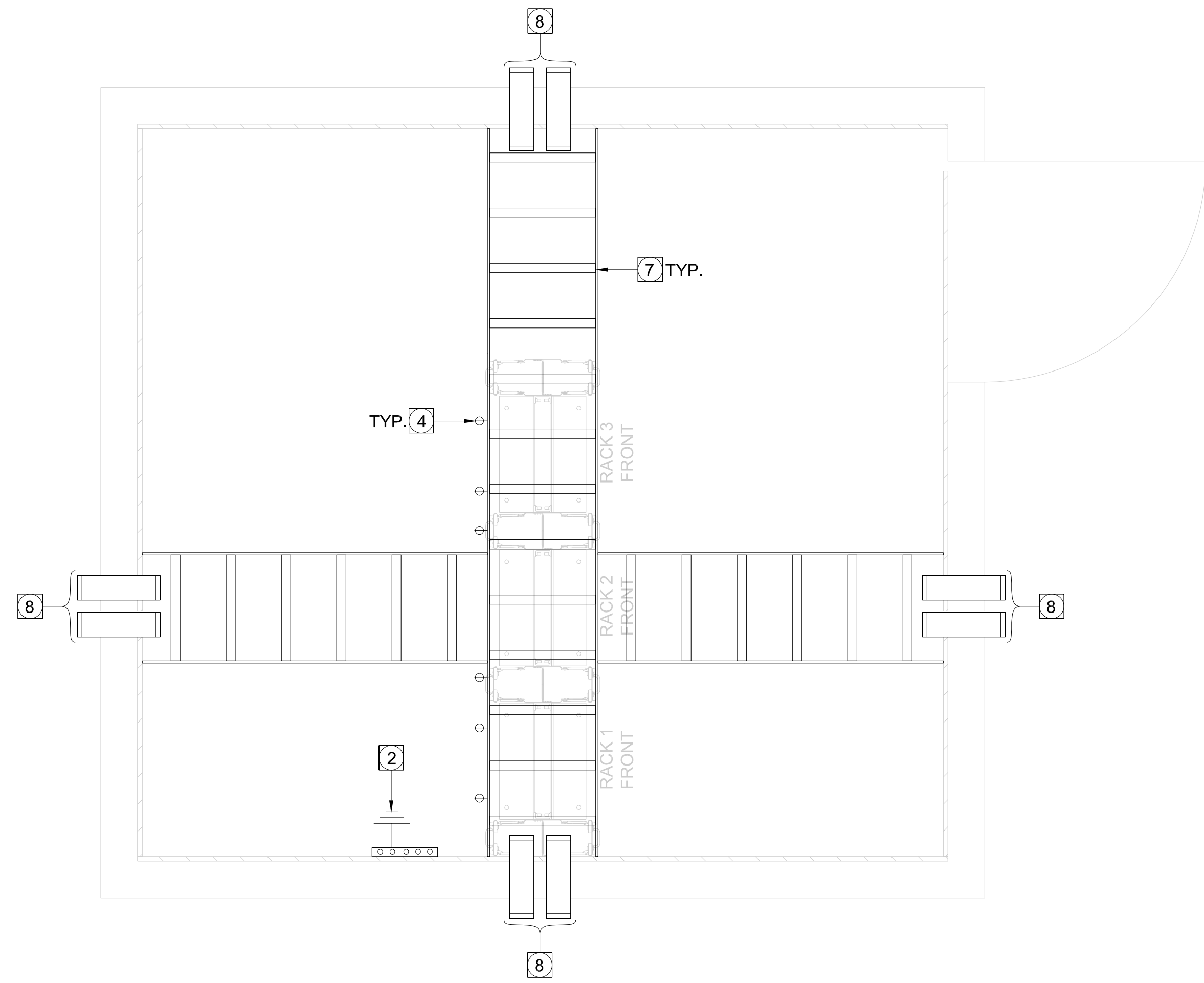
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RENAME

DATE

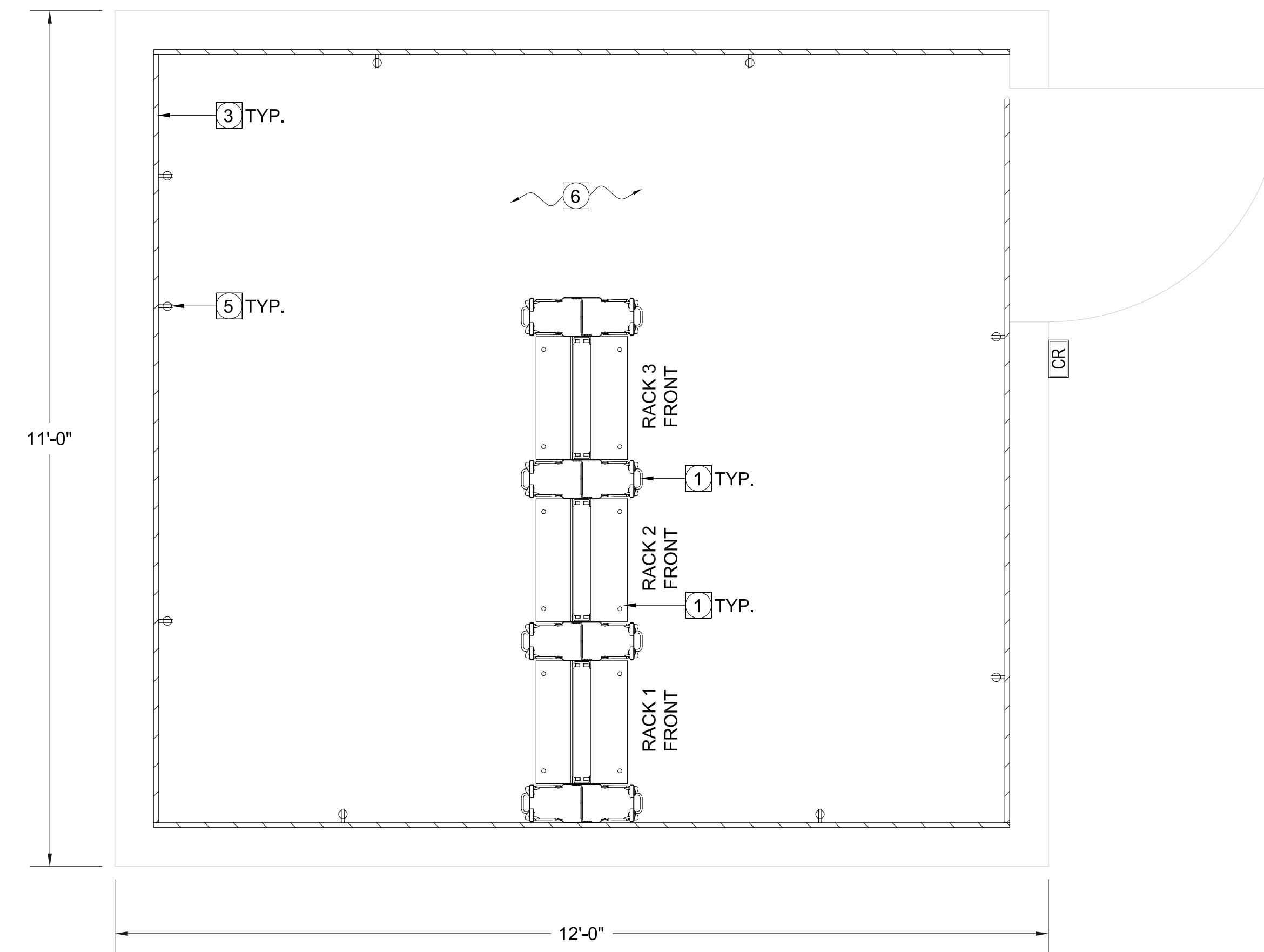
SCALE

TYPICAL BDF
 DATE
 SCALE
 LV4.01



TYPICAL IDF CABLE RUNWAY PLAN

SCALE: 2
 3/4"=1'-0"



TYPICAL IDF EQUIPMENT PLAN

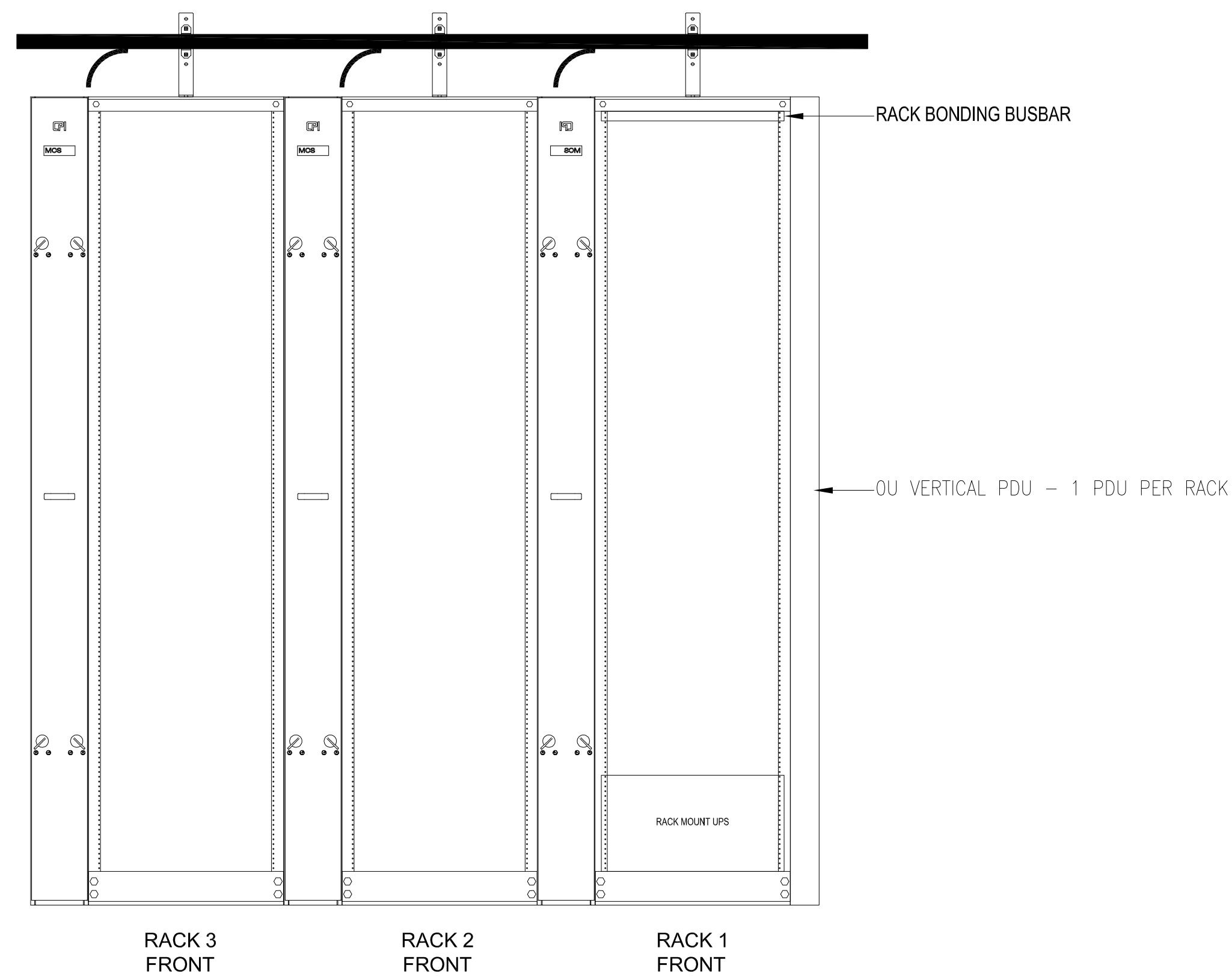
SCALE: 1
 3/4"=1'-0"

SPECIFIC PLAN NOTES

- 1 7' X 19" 2-POST EQUIPMENT RACK WITH 6" DOUBLE-SIDED VERTICAL WIRE MANAGERS.
- 2 20" TELECOMMUNICATION GROUND BUS BAR MOUNTED AT 7' 6".
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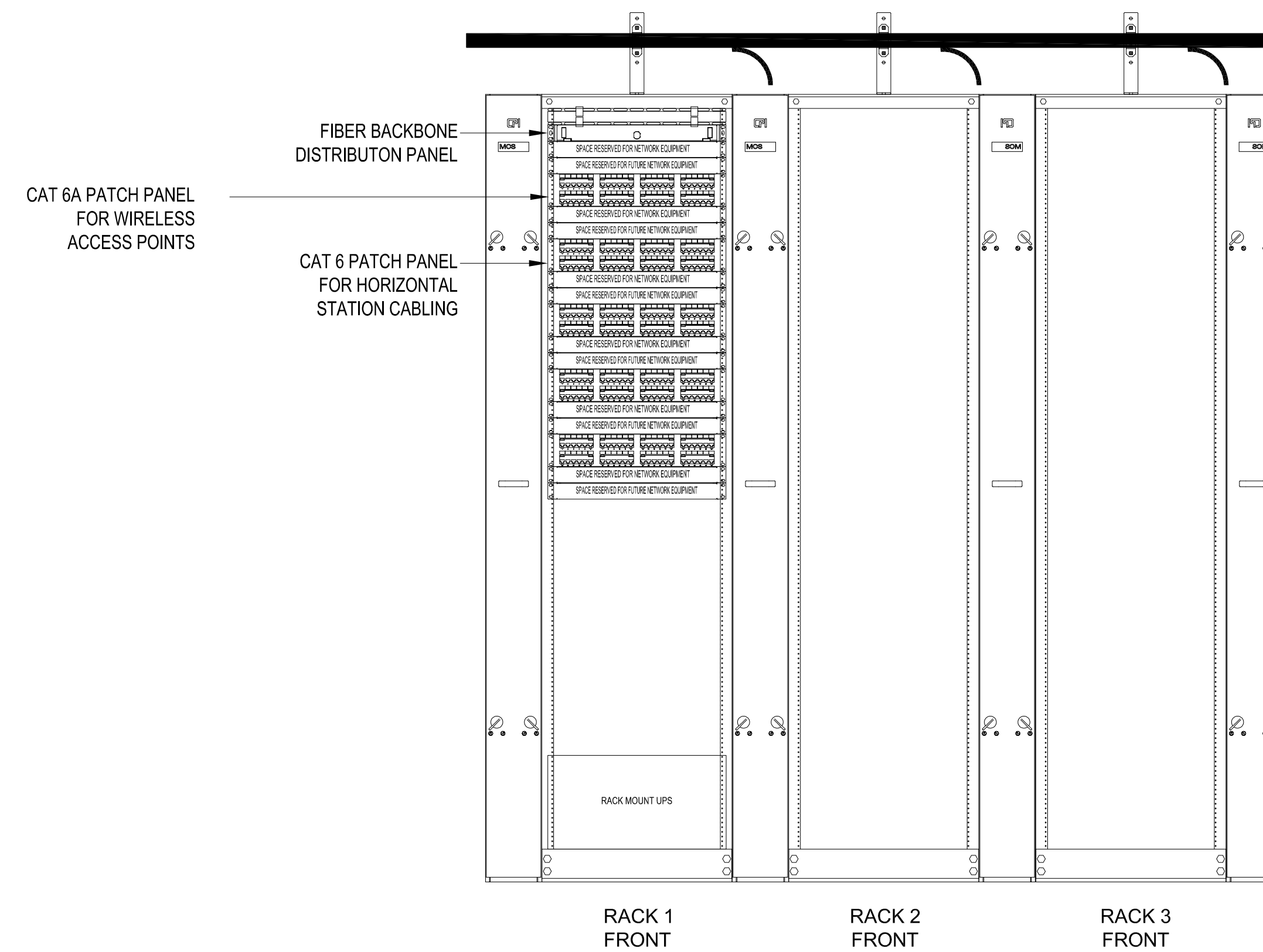
GENERAL NOTES

1. THE ROOM SIZE SHOULD BE 125SQ FT. PROVIDE 3 FEET WIDE LOCKABLE DOOR. DO NOT PROVIDE DROP CEILING. ENSURE A MINIMUM CLEARANCE OF 8'-6" BELOW LIGHT FIXTURES AND OTHER CEILING MOUNTED FIXTURES. PROVIDE SEALED CONCRETE FLOOR. PROVIDE 8' X 4' X 3/4" FIRE-RETARDANT PLYWOOD BACKBOARD AROUND THE PERIMETER OF THE ROOM TO SUPPORT WALL MOUNTED EQUIPMENT.
2. PROVIDE ADEQUATE AND UNIFORM LIGHTING THAT PROVIDES A MINIMUM EQUIVALENT OF 50 FOOT-CANDLES WHEN MEASURED 3 FT. ABOVE THE FINISHED FLOOR LEVEL. LOCATE LIGHT FIXTURES A MINIMUM OF 8.5 FT. ABOVE THE FINISHED FLOOR. LOCATE LIGHT SWITCHES NEAR THE ROOM ENTRANCE. EMERGENCY LIGHTING SYSTEMS WHICH OPERATE ON TRICKLE-CHARGE STORAGE BATTERIES ARE DESIRABLE AS A SAFETY PRECAUTION IN THE EVENT OF AN INADVERTENT POWER OUTAGE. POWER FOR THE LIGHTING SHOULD NOT COME FROM THE SAME CIRCUITS AS POWER FOR THE TELECOMMUNICATIONS EQUIPMENT.
3. PROVIDE INDUSTRY STANDARD POWER LOAD OF 3KW PER RACK BRINGING TOTAL POWER REQUIRED TO 9KW.
4. DRY-BULB TEMPERATURE (°F) PER ASHRAE THERMAL GUIDELINES:
 - a. 65 °F TO 80 °F (RECOMMENDED)
 - b. 59 °F TO 90 °F (ALLOWABLE)
5. PROVIDE WET FIRE SPRINKLER WITH PROTECTIVE CAGE.
6. PROVIDE SURVEILLANCE CAMERAS IN IDF ROOM FOR MONITORING FROM NETWORK OPERATION CENTER.



TYPICAL IDF RACK ELEVATION - REAR

SCALE: 4
 1"=1'-0"



TYPICAL IDF RACK ELEVATION - FRONT

SCALE: 3
 1"=1'-0"

PROJECT #

CONSULT

NOT FOR CONSTRUCTION

MIRACOSTA COLLEGE

1 BARNARD DR,
 OCEANSIDE, CA 92056

REVISIONS

NO.	DATE	DESCRIPTION

REVISIONS

TYPICAL IDF

ISSUES

DATE

SCALE

LV4.02

(DIMENSIONS PRINTED ON 30"X42" SHEET)



APPENDIX 27 - DIVISION 27

CAMPUS AUDIOVISUAL SYSTEMS DESIGN AND INSTALLATION GUIDELINES



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General

Purpose

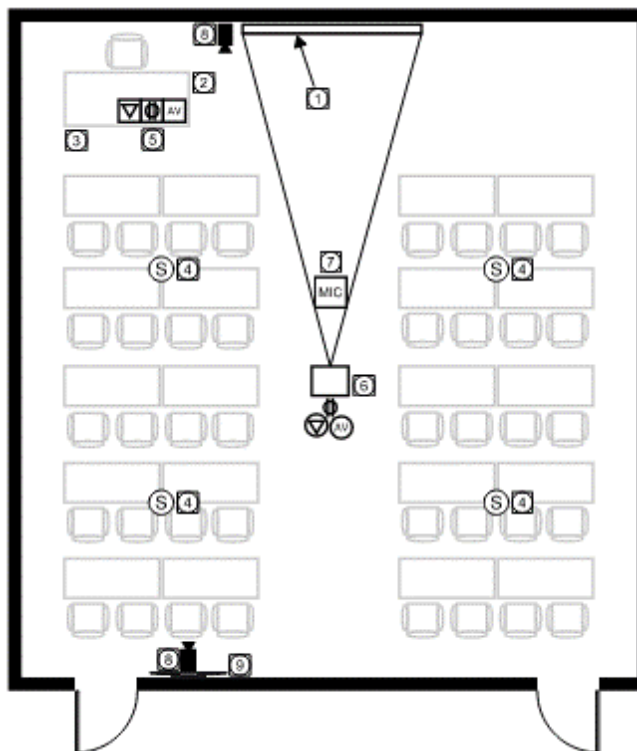
The MiraCosta Community College District is looking to standardize all future new construction and renovation projects with consistency in the AV system design and implementation. This includes instructional spaces, meeting rooms, and any other spaces throughout the district that may have an AV component.

The intent of this document is to provide a standard for design and installation guidelines that will be used for all MiraCosta College (MCC) facilities requiring an AV system(s). This document provides typical layouts for various room types and ideal technology locations. Layouts may not be an exact representation of a room nor are they drawn to scale. Any locations of floor boxes and furniture shown is for illustration and actual locations must comply with ADA. The intent is to illustrate the typical quantities and application of AV system equipment. Actual quantities of individual AV devices shall vary per application.

Typical AV Room Layouts

Regular Classroom

Diagram



Legend:

1. Projector Screen, Pull-Down
2. AV Equipment in Lectern
3. Touch Panel
4. Ceiling Loudspeakers
5. Floor Box
6. Ceiling-Mounted Projector
7. Ceiling Microphone
8. Camera
9. Gallery View Display

Audio Visual Equipment

1. Furniture
 - a. Instructor station shall be provided by the District and installed by the contractor.
 - b. Instructor station shall be Spectrum Industries Freedom One E-Lift with equipment rack.

- c. Equipment rack shall be secured by front locking door.
 - d. Equipment rack shall be fitted with a power surge protector sufficient for the equipment installed within the rack.
2. Cable Cubby
- a. Cable cubby and accessories shall be provided by the District and installed by the contractor.
 - b. Cable cubby shall be Extron Cable Cubby 500 (70-1045-02).
 - c. Cable cubby accessories are as follows:
 - i. Extron AC+USB 314 US, Cord (60-1891-01)
 - ii. Extron Retractor HDMI (70-1065-04)
 - iii. Extron Retractor USB-C – HDMI (70-1065-51)
 - iv. Extron Retractor Filler Module (70-1065-35)
3. Computer
- a. Computer provided and configured by District, but contractor installed.
 - b. Keyboard and mouse shall be wired.
 - c. Computer monitor shall be installed by the contractor. The monitor mount shall be Ergotron LX Series Desktop Monitor Arm (45-241-026).
4. Media Devices
- a. Document camera shall be provided by the District and installed by the contractor.
 - b. Document camera shall be Lumens.
 - c. Document camera shall be installed on left shelf of instructor station. Document camera shall be secured to the surface of the shelf.
 - d. Auxiliary AV input shall be installed in the cable cubby for use with temporary AV sources, such as a District provided Blu-ray player.
 - e. Wireless screen sharing device shall be provided by the District and installed by the contractor. Wireless screen sharing device shall be Vivi.
5. Video Projector
- a. Video projector shall be provided by the District and installed by the contractor.
 - b. Video projector specifications:
 - i. 6,000 ANSI lumens, minimum
 - ii. Video projector light source shall be laser.
 - iii. WUXGA (1920 x 1200 pixels) to support 1080p video formats and higher computer resolutions.
 - iv. Video projector lens shall be selected based on video projector placement.
 - v. Video projector and lens shall be Epson
6. Projector Ceiling Mount
- a. Projector ceiling mount shall be provided by contractor.
 - b. Projector ceiling mount shall be Peerless PRG Precision (PRG-UNV).
7. Projector Screen
- a. Projector screen shall be provided by the contractor.
 - b. Projector screen specifications:
 - i. Sized appropriately for a 6:1 ratio (Furthest Viewer:Height of Screen).
 - ii. Bottom of screen image shall be no less than 4' above the finished floor.
 - iii. 16:10 aspect ratio.
 - iv. Screen material shall be matte white with black boarder
 - v. 1.0 gain.

- vi. Model shall be Da-Lite Model C with CSR (Model #79884, 58”H x 104”W, 119”D).
8. Cameras
- a. Cameras for Hyflex functionality shall be provided by the District and installed by the contractor.
 - b. Camera at front of room shall be AVer TR530+ (PAVTR530P). Camera shall be installed upright on the front wall of the classroom near the instructor station. Height of mounting of camera shall be 96”-108” AFF to the bottom of the camera. Camera mount shall be AVer PTMLTCCM01.
 - c. Camera at back of room shall be AVer TR333V2 (PAVTR333V2). Camera shall be installed upright on the back wall of the classroom above the Gallery View display. Height of mounting of camera shall be 96”-108” AFF to the bottom of the camera. Camera mount shall be AVer PTMLTCCM01.
9. Gallery View Display
- a. Gallery View display shall be provided by the District and installed by the contractor.
 - b. Gallery View display shall be Samsung with size appropriate to the distance from the instructor station to the back wall. Size shall be coordinated with the District.
 - c. Gallery View display shall be mounted on the wall directly across from the instructor station. Gallery View display mount shall be Chief PDRUB.
10. Media Switcher
- a. Media switcher shall be provided by the District and installed by the contractor
 - b. Media switcher shall be Extron IN1808 IPCP Q MA 70.
11. Audio
- a. All components shall be provided by the District and installed by the contractor.
 - b. Ceiling loudspeakers shall be Extron FF 220T. For a typical ceiling height of 9’ to 10’ AFF, ceiling loudspeakers shall be spaced no more than 15’ apart and 6’ from a wall. Loudspeakers shall be evenly distributed throughout the ceiling as much as possible.
 - c. Ceiling microphone shall be Shure MXA920W-US. For a typical ceiling height of 9’ to 10’ AFF, ceiling microphone quantity shall be determined based on 30’ radius coverage maximum, per microphone. Microphone/s shall be positioned to maximize coverage of instruction and student space.
12. Control System
- a. Control system shall be provided by the District and installed by the contractor.
 - b. Touch panel shall be Extron TLP Pro 1025T.
 - c. Network switch for system shall be provided by the District and installed by the contractor in the AV equipment rack.
13. Software
- a. Software for remote management shall be Extron Global Configurator.
14. Cabling and Connectors
- a. Contractor shall provide the following:
 - i. Auxiliary HDMI input at instructor station cable cubby.
 - ii. USB extension cable from room computer at instructor station cable cubby.
 - iii. 1/8” analog audio output jack for connection to portable ALS.

Pathways and Electrical Requirements

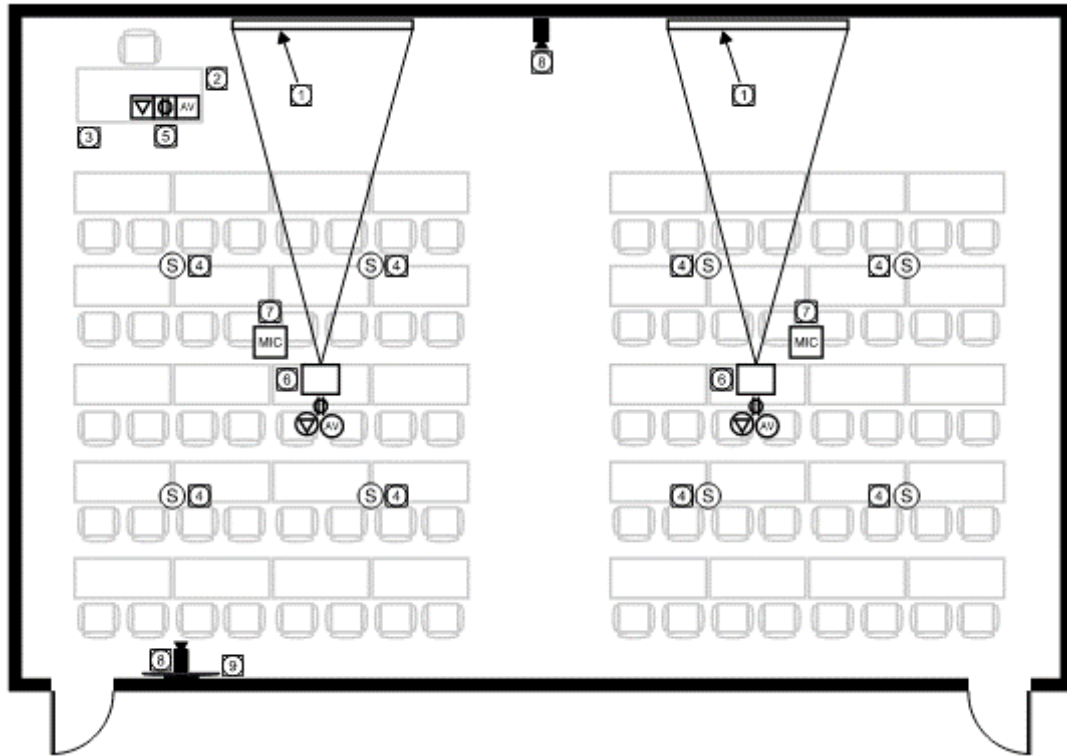
- 1. Instructor Station Floor Box
 - a. Floor box shall be Wiremold RFBA Series floor box.

- b. 2-each, 1-1/4" conduit stub above accessible ceiling with plastic bushing.
 - c. Power outlet shall be 20-amp, 120-volt, quad, dedicated.
- 2. Video Projector Location
 - a. Power outlet shall be 20-amp, 120-volt, duplex, dedicated.
- 3. Gallery View Display Location
 - a. Power outlet shall be 20-amp, 120-volt, duplex.

Data Requirements

- 1. Instructor Station Floor Box
 - a. 4-each, RJ45, Data
- 2. Video Projector
 - a. 2-each, RJ45, Data
- 3. Front Wall/Teaching Wall
 - a. 2-each, RJ45, Data
- 4. Side Walls
 - a. 2-each, RJ45, Data
- 5. Rear Wall
 - a. 2-each, RJ45, Data
- 6. Wireless Access Point
 - a. 2-each, RJ45, Data
- 7. Camera
 - a. 2-each, RJ45, Data

Large Classroom Diagram



Legend:

1. Projector Screen, Pull-Down
2. AV Equipment in Lectern
3. Touch Panel
4. Ceiling Loudspeakers
5. Floor Box
6. Ceiling-Mounted Projector
7. Ceiling Microphone
8. Camera
9. Gallery View Display

Audio Visual Equipment

1. Furniture
 - a. Instructor station shall be provided by the District and installed by the contractor.
 - b. Instructor station shall be Spectrum Industries Freedom One E-Lift with equipment rack.
 - c. Equipment rack shall be fitted with a power surge protector sufficient for the equipment installed within the rack.
 - d. Equipment rack shall be secured by front locking door.
2. Cable Cubby
 - a. Cable cubby and accessories shall be provided by the District and installed by the contractor.

- b. Cable cubby shall be Extron Cable Cubby 500 (70-1045-02).
- c. Cable cubby accessories are as follows:
 - i. Extron AC+USB 314 US, Cord (60-1891-01)
 - ii. Extron Retractor HDMI (70-1065-04)
 - iii. Extron Retractor USB-C – HDMI (70-1065-51)
 - iv. Extron Retractor Filler Module (70-1065-35)
- 3. Computer
 - a. Computer provided and configured by District, but contractor installed.
 - b. Keyboard and mouse shall be wired.
 - c. Computer monitor shall be installed by the contractor. The monitor mount shall be Ergotron LX Series Desktop Monitor Arm (45-241-026).
- 4. Media Devices
 - a. Document camera shall be provided by the District and installed by the contractor.
 - b. Document camera shall be Lumens.
 - c. Document camera shall be installed on left shelf of instructor station. Document camera shall be secured to the surface of the shelf.
 - d. Auxiliary AV input shall be installed in the cable cubby for use with temporary AV sources, such as a District provided Blu-ray player.
 - e. Wireless screen sharing device shall be provided by the District and installed by the contractor. Wireless screen sharing device shall be Vivi.
- 5. Video Projector
 - a. Video projector shall be provided by the District and installed by the contractor.
 - b. Video projector specifications:
 - iv. 6,000 ANSI lumens, minimum
 - v. Video projector light source shall be laser.
 - i. WUXGA (1920 x 1200 pixels) to support 1080p video formats and higher computer resolutions.
 - ii. Video projector lens shall be selected based on video projector placement.
 - iii. Video projector and lens shall be Epson
- 6. Projector Ceiling Mount
 - a. Projector ceiling mount shall be provided by contractor.
 - b. Projector ceiling mount shall be Peerless PRG Precision (PRG-UNV).
- 7. Projector Screen
 - a. Projector screen shall be provided by the contractor.
 - b. Projector screen specifications:
 - i. Sized appropriately for a 6:1 ratio (Furthest Viewer:Height of Screen).
 - ii. Bottom of screen image shall be no less that 4' above the finished floor.
 - iii. 16:10 aspect ratio.
 - iv. Screen material shall be matte white with black boarder
 - v. 1.0 gain.
 - vi. Model shall be Da-Lite Model C with CSR (Model #79884, 58"H x 104"W, 119"D).
- 8. Cameras
 - a. Cameras for Hyflex functionality shall be provided by the District and installed by the contractor.
 - b. Camera at front of room shall be AVer TR530+ (PAVTR530P). Camera shall be installed upright on the front wall of the classroom near the instructor station. Height of mounting

of camera shall be 96"-108" AFF to the bottom of the camera. Camera mount shall be AVer PTMLTCCM01.

- c. Camera at back of room shall be AVer TR333V2 (PAVTR333V2). Camera shall be installed upright on the back wall of the classroom above the Gallery View display. Height of mounting of camera shall be 96"-108" AFF to the bottom of the camera. Camera mount shall be AVer PTMLTCCM01.
9. Gallery View Display
 - a. Gallery View display shall be provided by the District and installed by the contractor.
 - b. Gallery View display shall be Samsung with size appropriate to the distance from the instructor station to the back wall. Size shall be coordinated with the District.
 - c. Gallery View display shall be mounted on the wall directly across from the instructor station. Gallery View display mount shall be Chief PDRUB.
 10. Media Switcher
 - a. Media switcher shall be provided by the District and installed by the contractor
 - b. Media switcher shall be Extron IN1808 IPCP Q MA 70.
 11. Audio
 - a. All components shall be provided by the District and installed by the contractor.
 - b. Ceiling loudspeakers shall be Extron FF 220T. For a typical ceiling height of 9' to 10' AFF, ceiling loudspeakers shall be spaced no more than 15' apart and 6' from a wall. Loudspeakers shall be evenly distributed throughout the ceiling as much as possible.
 - c. Ceiling microphone shall be Shure MXA920W-US. For a typical ceiling height of 9' to 10' AFF, ceiling microphone quantity shall be determined based on 30' radius coverage maximum, per microphone. Microphone/s shall be positioned to maximize coverage of instruction and student space.
 12. Control System
 - a. Control system shall be provided by the District and installed by the contractor.
 - b. Touch panel shall be Extron TLP Pro 1025T.
 - c. Network switch for system shall be provided by the District and installed by the contractor in the AV equipment rack.
 13. Software
 - a. Software for remote management shall be Extron Global Configurator.
 14. Cabling and Connectors
 - a. Contractor shall provide the following:
 - i. Auxiliary HDMI input at instructor station cable cubby.
 - ii. USB extension cable from room computer at instructor station cable cubby.
 - iii. 1/8" analog audio output jack for connection to portable ALS.

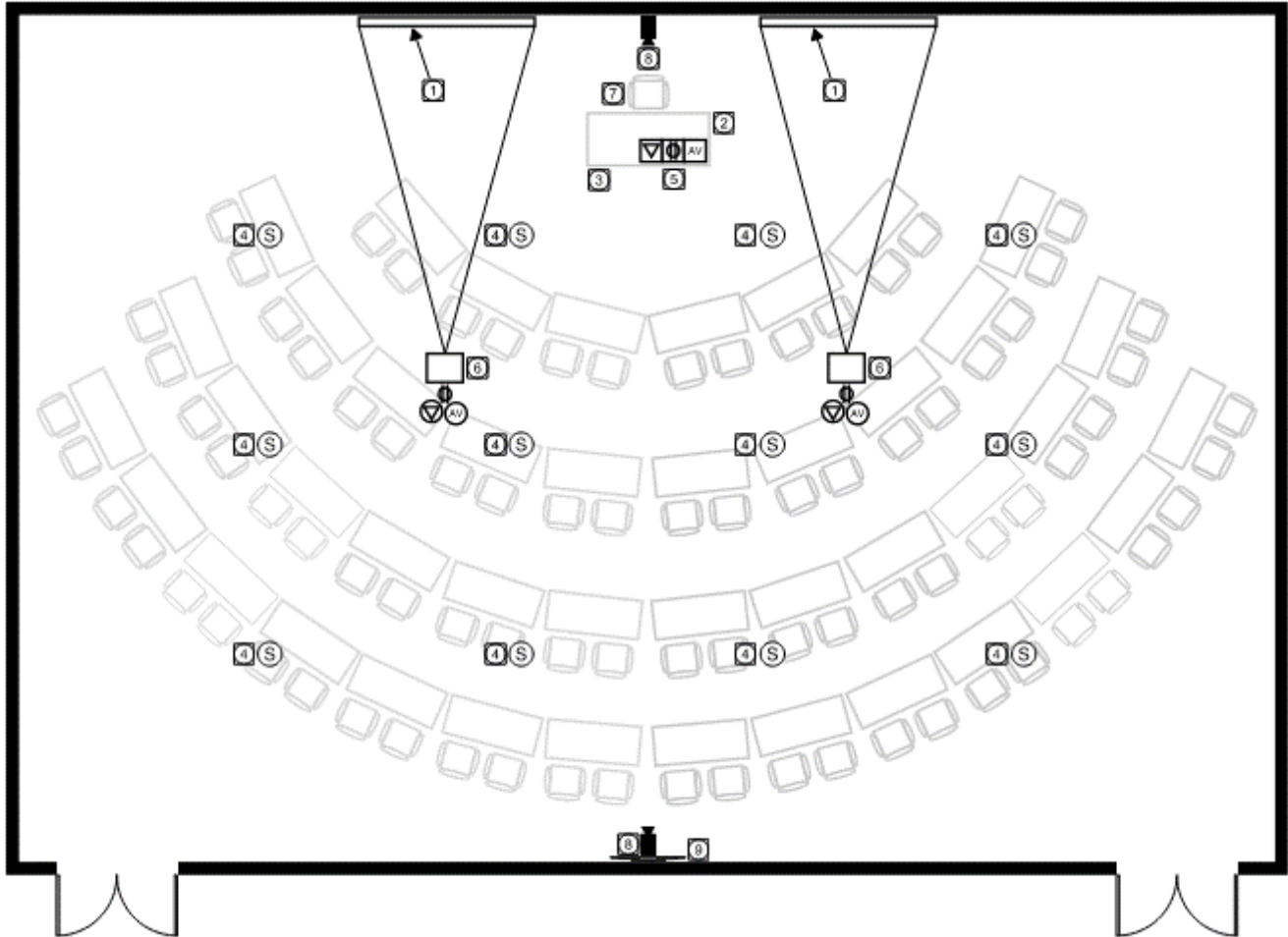
Pathways and Electrical Requirements

1. Instructor Station Floor Box
 - a. Floor box shall be Wiremold RFBA Series floor box.
 - b. 2-each, 1-1/4" conduit stub above accessible ceiling with plastic bushing.
 - c. Power outlet shall be 20-amp, 120-volt, quad, dedicated.
2. Video Projector Location
 - a. Power outlet shall be 20-amp, 120-volt, duplex, dedicated.
3. Gallery View Display Location
 - a. Power outlet shall be 20-amp, 120-volt, duplex.

Data Requirements

1. Instructor Station Floor Box
 - a. 4-each, RJ45, Data
2. Video Projector
 - a. 2-each, RJ45, Data
3. Front Wall/Teaching Wall
 - a. 2-each, RJ45, Data
4. Side Walls
 - a. 2-each, RJ45, Data
5. Rear Wall
 - a. 2-each, RJ45, Data
6. Wireless Access Point
 - a. 2-each, RJ45, Data
7. Camera
 - a. 2-each, RJ45, Data

Lecture Hall
Diagram



Legend:

1. Projector Screen, Pull-Down
2. AV Equipment in Lectern
3. Touch Panel
4. Ceiling Loudspeakers
5. Floor Box
6. Ceiling-Mounted Projector
7. (2) Wireless Bodypack, (2) Handheld Microphones
8. Camera
9. Gallery View Display

Audio Visual Equipment

1. Furniture
 - a. Instructor station shall be provided by the District and installed by the contractor.
 - b. Instructor station shall be Spectrum Industries Freedom One E-Lift with equipment rack.

- c. Equipment rack shall be fitted with a power surge protector sufficient for the equipment installed within the rack.
 - d. Equipment rack shall be secured by front locking door.
 - 2. Cable Cubby
 - a. Cable cubby and accessories shall be provided by the District and installed by the contractor.
 - b. Cable cubby shall be Extron Cable Cubby 500 (70-1045-02).
 - c. Cable cubby accessories are as follows:
 - i. Extron AC+USB 314 US, Cord (60-1891-01)
 - ii. Extron Retractor HDMI (70-1065-04)
 - iii. Extron Retractor USB-C – HDMI (70-1065-51)
 - iv. Extron Retractor Filler Module (70-1065-35)
 - 3. Computer
 - a. Computer provided and configured by District, but contractor installed.
 - b. Keyboard and mouse shall be wired.
 - c. Computer monitor shall be installed by the contractor. The monitor mount shall be Ergotron LX Series Desktop Monitor Arm (45-241-026).
 - 4. Media Devices
 - a. Document camera shall be provided by the District and installed by the contractor.
 - b. Document camera shall be Lumens.
 - c. Document camera shall be installed on left shelf of instructor station. Document camera shall be secured to the surface of the shelf.
 - d. Auxiliary AV input shall be installed in the cable cubby for use with temporary AV sources, such as a District provided Blu-ray player.
 - e. Wireless screen sharing device shall be provided by the District and installed by the contractor. Wireless screen sharing device shall be Vivi.
 - 5. Video Projector
 - a. Video projector shall be provided by the District and installed by the contractor.
 - b. Video projector specifications:
 - vi. 6,000 ANSI lumens, minimum
 - vii. Video projector light source shall be laser.
 - i. WUXGA (1920 x 1200 pixels) to support 1080p video formats and higher computer resolutions.
 - ii. Video projector lens shall be selected based on video projector placement.
 - iii. Video projector and lens shall be Epson
 - 6. Projector Ceiling Mount
 - a. Projector ceiling mount shall be provided by contractor.
 - b. Projector ceiling mount shall be Peerless PRG Precision (PRG-UNV).
 - 7. Projector Screen
 - a. Projector screen shall be provided by the contractor.
 - b. Projector screen specifications:
 - i. Sized appropriately for a 6:1 ratio (Furthest Viewer:Height of Screen).
 - ii. Bottom of screen image shall be no less that 4' above the finished floor.
 - iii. 16:10 aspect ratio.
 - iv. Screen material shall be matte white with black boarder
 - v. 1.0 gain.

- vi. Model shall be Da-Lite Model C with CSR (Model #79884, 58”H x 104”W, 119”D).
8. Cameras
- a. Cameras for Hyflex functionality shall be provided by the District and installed by the contractor.
 - b. Camera at front of room shall be AVer TR530+ (PAVTR530P). Camera shall be installed upright on the front wall of the classroom near the instructor station. Height of mounting of camera shall be 96”-108” AFF to the bottom of the camera. Camera mount shall be AVer PTMLTCCM01.
 - c. Camera at back of room shall be AVer TR333V2 (PAVTR333V2). Camera shall be installed upright on the back wall of the classroom above the Gallery View display. Height of mounting of camera shall be 96”-108” AFF to the bottom of the camera. Camera mount shall be AVer PTMLTCCM01.
9. Gallery View Display
- a. Gallery View display shall be provided by the District and installed by the contractor.
 - b. Gallery View display shall be Samsung with size appropriate to the distance from the instructor station to the back wall. Size shall be coordinated with the District.
 - c. Gallery View display shall be mounted on the wall directly across from the instructor station. Gallery View display mount shall be Chief PDRUB.
10. Media Switcher
- a. Media switcher shall be provided by the District and installed by the contractor
 - b. Media switcher shall be Extron IN1808 IPCP Q MA 70.
11. Audio
- a. All components shall be provided by the District and installed by the contractor.
 - b. Ceiling loudspeakers shall be Extron FF 220T. For a typical ceiling height of 9’ to 10’ AFF, ceiling loudspeakers shall be spaced no more than 15’ apart and 6’ from a wall. Loudspeakers shall be evenly distributed throughout the ceiling as much as possible.
 - c. Microphones shall be as follows:
 - i. (2) Shure ULXD2/B58 Handheld Transmitters.
 - ii. (2) Shure ULXD1 Belt Pack Transmitters with Shure WL185 Lavalier Microphones.
 - iii. Shure ULXD4Q 4-Channel Microphone Receiver.
 - iv. (4) Shure SB900B Rechargeable Batteries.
 - v. (2) Shure SBC200-US Dual Docking Recharging Stations.
15. Control System
- a. Control system shall be provided by the District and installed by the contractor.
 - b. Touch panel shall be Extron TLP Pro 1025T.
 - c. Network switch for system shall be provided by the District and installed by the contractor in the AV equipment rack.
16. Software
- a. Software for remote management shall be Extron Global Configurator.
17. Cabling and Connectors
- a. Contractor shall provide the following:
 - i. Auxiliary HDMI input at instructor station cable cubby.
 - ii. USB extension cable from room computer at instructor station cable cubby.
 - iii. 1/8” analog audio output jack for connection to portable ALS.

Pathways and Electrical Requirements

1. Instructor Station Floor Box
 - a. Floor box shall be Wiremold RFBA Series floor box.
 - b. 2-each, 1-1/4" conduit stub above accessible ceiling with plastic bushing.
 - c. Power outlet shall be 20-amp, 120-volt, quad, dedicated.
2. Video Projector Location
 - a. Power outlet shall be 20-amp, 120-volt, duplex, dedicated.
3. Gallery View Display Location
 - a. Power outlet shall be 20-amp, 120-volt, duplex.

Data Requirements

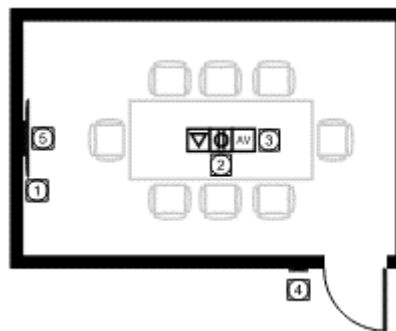
1. Instructor Station Floor Box
 - a. 4-each, RJ45, Data
2. Video Projector
 - a. 2-each, RJ45, Data
3. Front Wall/Teaching Wall
 - a. 2-each, RJ45, Data
4. Side Walls
 - a. 2-each, RJ45, Data
5. Rear Wall
 - a. 2-each, RJ45, Data
6. Wireless Access Point
 - a. 2-each, RJ45, Data
7. Camera
 - a. 2-each, RJ45, Data

Small Conference Room

Diagram

Legend:

1. Flat Panel Display
2. Floor Box
3. Room Controller on Table
4. Scheduling Panel at 54" AFF
5. Videoconferencing All-In-One Bar



Audio Visual Equipment

1. Furniture
 - a. Furniture shall be provided by others.
2. Computer
 - a. Computer provided and configured by District, but contractor installed.
 - b. Keyboard and mouse shall be wired.
 - c. Computer shall be mounted behind the display using District-provided computer wall mount bracket.
3. Media Devices
 - a. Wireless screen sharing device shall be provided the District and installed by the contractor. Wireless screen sharing device shall be installed behind the display. Wireless screen sharing device shall be Vivi.
 - b. Hardwired HDMI connection from the display shall be extended through the floor box to the conference room table. HDMI extenders shall be Extron DTP T HD2 4K.
4. Flat Panel Display
 - a. Flat panel display shall be provided by the District and installed by the contractor.
 - b. Flat panel display shall be Samsung QBB Series.
 - c. Typical size shall be 55" diagonal. Model and dimensions shall be coordinated with and approved by the District.
5. Flat Panel Display Mount
 - a. Flat panel display mount shall be provided by the District and installed by the contractor.
 - b. Flat panel display mount shall be Tripplite DWM3780X.
 - c. Flat panel display mount specified is typical. Model shall be coordinated with and approved by the District.
6. Videoconferencing
 - a. Videoconferencing device shall be provided by the District and installed by the contractor.
 - b. Videoconferencing device shall be AVer PTZ Video Bar (VB342 Pro).
 - c. Videoconferencing device shall be installed below the front display with the center of the camera 44" AFF. Design shall be flexible in that the District may choose to move the videoconferencing device to above the display per individual Department preferences.
7. Control System
 - a. Control system shall be provided by the District and installed by the contractor.

- b. Controller shall be MediaLink Plus Controller MLC Plus 100 Black.
- c. Controller shall be mounted on the conference room table using Extron SMB 112 Black.
- 8. Room Scheduler
 - a. Room scheduler shall be provided by the District and installed by the contractor.
 - b. Room scheduler shall be Visix Connect (VX-C-CRS).
 - c. Room scheduler shall be mounted on a wall outside the room at 54" AFF to the center of the device.
- 9. Software
 - a. Software for remote management shall be Extron Global Configurator.
- 10. Cabling and Connectors
 - a. Contractor shall provide the following:
 - i. Auxiliary HDMI input at conference room table.
 - ii. 1/8" analog audio output jack for connection to portable ALS.

Pathways and Electrical Requirements

- 1. Conference Room Table Floor Box
 - a. Floor box shall be Wiremold RFBA Series floor box.
 - b. 2-each, 1-1/4" conduit stub above accessible ceiling with plastic bushing.
 - c. Power outlet shall be 20-amp, 120-volt, quad, dedicated.
- 2. Flat Panel Display Location
 - a. Power outlet shall be 20-amp, 120-volt, duplex.

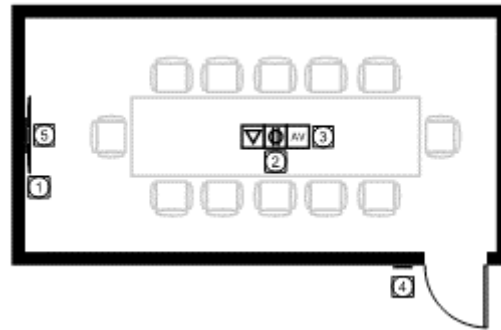
Data Requirements

- 1. Conference Room Table Floor Box
 - a. 4-each, RJ45, Data
- 2. Flat Panel Display
 - a. 4-each, RJ45, Data
- 3. Side Walls
 - a. 2-each, RJ45, Data
- 4. Rear Wall
 - a. 2-each, RJ45, Data
- 5. Wireless Access Point
 - a. 2-each, RJ45, Data
- 6. Scheduling Panel
 - a. 1-each, RJ45, Data

Regular Conference Room Diagram

Legend:

1. Flat Panel Display
2. Floor Box
3. Room Controller on Table
4. Scheduling Panel at 54" AFF
5. Videoconferencing All-In-One Bar



Audio Visual Equipment

1. Furniture
 - a. Furniture shall be provided by others.
2. Computer
 - a. Computer provided and configured by District, but contractor installed.
 - b. Keyboard and mouse shall be wired.
 - c. Computer shall be mounted behind the display using District-provided computer wall mount bracket.
3. Media Devices
 - a. Wireless screen sharing device shall be provided the District and installed by the contractor. Wireless screen sharing device shall be installed behind the display. Wireless screen sharing device shall be Vivi.
 - b. Hardwired HDMI connection from the display shall be extended through the floor box to the conference room table. HDMI extenders shall be Extron DTP T HD2 4K.
4. Flat Panel Display
 - a. Flat panel display shall be provided by the District and installed by the contractor.
 - b. Flat panel display shall be Samsung QBB Series.
 - c. Typical size shall be 55" diagonal. Model and dimensions shall be coordinated with and approved by the District.
5. Flat Panel Display Mount
 - a. Flat panel display mount shall be provided by the District and installed by the contractor.
 - b. Flat panel display mount shall be Tripplite DWM3780X.
 - c. Flat panel display mount specified is typical. Model shall be coordinated with and approved by the District.
6. Videoconferencing
 - a. Videoconferencing device shall be provided by the District and installed by the contractor.
 - b. Videoconferencing device shall be AVer PTZ Video Bar (VB342 Pro).
 - c. Videoconferencing device shall be installed below the front display with the center of the camera 44" AFF. Design shall be flexible in that the District may choose to move the videoconferencing device to above the display per individual Department preferences.
7. Control System
 - a. Control system shall be provided by the District and installed by the contractor.

- b. Controller shall be MediaLink Plus Controller MLC Plus 100 Black.
- c. Controller shall be mounted on the conference room table using Extron SMB 112 Black.
- 8. Room Scheduler
 - a. Room scheduler shall be provided by the District and installed by the contractor.
 - b. Room scheduler shall be Visix Connect (VX-C-CRS).
 - c. Room scheduler shall be mounted on a wall outside the room at 54" AFF to the center of the device.
- 9. Software
 - a. Software for remote management shall be Extron Global Configurator.
- 10. Cabling and Connectors
 - a. Contractor shall provide the following:
 - i. Auxiliary HDMI input at conference room table.
 - ii. 1/8" analog audio output jack for connection to portable ALS.

Pathways and Electrical Requirements

- 1. Conference Room Table Floor Box
 - a. Floor box shall be Wiremold RFBA Series floor box.
 - b. 2-each, 1-1/4" conduit stub above accessible ceiling with plastic bushing.
 - c. Power outlet shall be 20-amp, 120-volt, quad, dedicated.
- 2. Flat Panel Display Location
 - a. Power outlet shall be 20-amp, 120-volt, duplex.

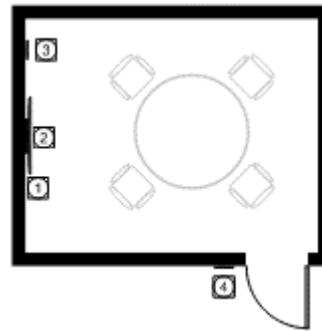
Data Requirements

- 1. Conference Room Table Floor Box
 - a. 4-each, RJ45, Data
- 2. Flat Panel Display
 - a. 4-each, RJ45, Data
- 3. Side Walls
 - a. 2-each, RJ45, Data
- 4. Rear Wall
 - a. 2-each, RJ45, Data
- 5. Wireless Access Point
 - a. 2-each, RJ45, Data
- 6. Scheduling Panel
 - a. 1-each, RJ45, Data

Study Room Diagram

Legend:

1. Flat Panel Display
2. HDMI Wall Plate at 18" AFF
3. Room Controller on wall
4. Scheduling Panel at 54" AFF



Audio Visual Equipment

1. Furniture
 - a. Furniture shall be provided by others.
2. Media Devices
 - a. Wireless screen sharing device shall be provided the District and installed by the contractor. Wireless screen sharing device shall be installed behind the display. Wireless screen sharing device shall be Vиви.
 - b. Hardwired HDMI connection from the display shall be passively extended through the the wall to an HDMI input plate below the display. HDMI input plate shall be mounted at 18" AFF.
3. Flat Panel Display
 - a. Flat panel display shall be provided by the District and installed by the contractor.
 - b. Flat panel display shall be Samsung QBB Series.
 - c. Typical size shall be 55" diagonal. Model and dimensions shall be coordinated with and approved by the District.
4. Flat Panel Display Mount
 - a. Flat panel display mount shall be provided by the District and installed by the contractor.
 - b. Flat panel display mount shall be Tripplite DWM3780X.
 - c. Flat panel display mount specified is typical. Model shall be coordinated with and approved by the District.
5. Control System
 - a. Control system shall be provided by the District and installed by the contractor.
 - b. Controller shall be MediaLink Plus Controller MLC Plus 100 Black.
 - c. Controller shall be mounted on the wall with top of device at 48" AFF.
6. Room Scheduler
 - a. Room scheduler shall be provided by the District and installed by the contractor.
 - b. Room scheduler shall be Visix Connect (VX-C-CRS).
 - c. Room scheduler shall be mounted on a wall outside the room at 54" AFF to the center of the device.
7. Software
 - a. Software for remote management shall be Extron Global Configurator.
8. Cabling and Connectors
 - a. Contractor shall provide the following:
 - i. Auxiliary HDMI input at conference room table.

- ii. 1/8" analog audio output jack for connection to portable ALS.

Pathways and Electrical Requirements

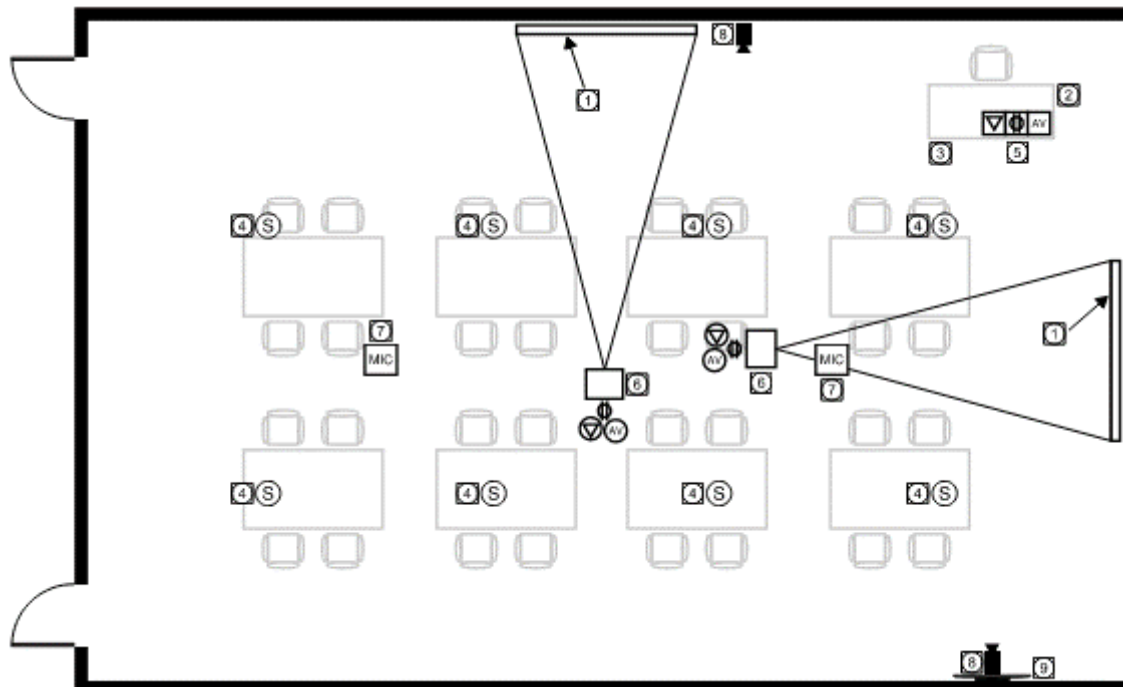
1. Flat Panel Display Location
 - a. Power outlet shall be 20-amp, 120-volt, duplex.

Data Requirements

1. Conference Room Table Floor Box
 - a. 4-each, RJ45, Data
2. Flat Panel Display
 - a. 4-each, RJ45, Data
3. Side Walls
 - a. 2-each, RJ45, Data
4. Rear Wall
 - a. 2-each, RJ45, Data
5. Wireless Access Point
 - a. 2-each, RJ45, Data
6. Scheduling Panel
 - a. 1-each, RJ45, Data

Multipurpose Room

Diagram



Legend:

1. Projector Screen, Pull-Down
2. AV Equipment in Lectern
3. Touch Panel
4. Ceiling Loudspeakers
5. Floor Box
6. Ceiling-Mounted Projector
7. Ceiling Microphone
8. Camera
9. Gallery View Display

Audio Visual Equipment

1. Furniture
 - a. Instructor station shall be provided by the District and installed by the contractor.
 - b. Instructor station shall be Spectrum Industries Freedom One E-Lift with equipment rack.
 - c. Equipment rack shall be fitted with a power surge protector sufficient for the equipment installed within the rack.
 - d. Equipment rack shall be secured by front locking door.
2. Cable Cubby
 - a. Cable cubby and accessories shall be provided by the District and installed by the contractor.
 - b. Cable cubby shall be Extron Cable Cubby 500 (70-1045-02).
 - c. Cable cubby accessories are as follows:
 - i. Extron AC+USB 314 US, Cord (60-1891-01)

- ii. Extron Retractor HDMI (70-1065-04)
 - iii. Extron Retractor USB-C – HDMI (70-1065-51)
 - iv. Extron Retractor Filler Module (70-1065-35)
- 3. Computer
 - a. Computer provided and configured by District, but contractor installed.
 - b. Keyboard and mouse shall be wired.
 - c. Computer monitor shall be installed by the contractor. The monitor mount shall be Ergotron LX Series Desktop Monitor Arm (45-241-026).
- 4. Media Devices
 - a. Document camera shall be provided by the District and installed by the contractor.
 - b. Document camera shall be Lumens.
 - c. Document camera shall be installed on left shelf of instructor station. Document camera shall be secured to the surface of the shelf.
 - d. Auxiliary AV input shall be installed in the cable cubby for use with temporary AV sources, such as a District provided Blu-ray player.
 - e. Wireless screen sharing device shall be provided by the District and installed by the contractor. Wireless screen sharing device shall be Vivi.
- 5. Video Projector
 - a. Video projector shall be provided by the District and installed by the contractor.
 - b. Video projector specifications:
 - viii. 6,000 ANSI lumens, minimum
 - ix. Video projector light source shall be laser.
 - i. WUXGA (1920 x 1200 pixels) to support 1080p video formats and higher computer resolutions.
 - ii. Video projector lens shall be selected based on video projector placement.
 - iii. Video projector and lens shall be Epson
- 6. Projector Ceiling Mount
 - a. Projector ceiling mount shall be provided by contractor.
 - b. Projector ceiling mount shall be Peerless PRG Precision (PRG-UNV).
- 7. Projector Screen
 - a. Projector screen shall be provided by the contractor.
 - b. Projector screen specifications:
 - i. Sized appropriately for a 6:1 ratio (Furthest Viewer:Height of Screen).
 - ii. Bottom of screen image shall be no less than 4' above the finished floor.
 - iii. 16:10 aspect ratio.
 - iv. Screen material shall be matte white with black border
 - v. 1.0 gain.
 - vi. Model shall be Da-Lite Model C with CSR (Model #79884, 58"H x 104"W, 119"D).
- 8. Cameras
 - a. Cameras for Hyflex functionality shall be provided by the District and installed by the contractor.
 - b. Camera at front of room shall be AVer TR530+ (PAVTR530P). Camera shall be installed upright on the front wall of the classroom near the instructor station. Height of mounting of camera shall be 96"-108" AFF to the bottom of the camera. Camera mount shall be AVer PTMLTCCM01.

- c. Camera at back of room shall be AVer TR333V2 (PAVTR333V2). Camera shall be installed upright on the back wall of the classroom above the Gallery View display. Height of mounting of camera shall be 96"-108" AFF to the bottom of the camera. Camera mount shall be AVer PTMLTCCM01.
- 9. Gallery View Display
 - a. Gallery View display shall be provided by the District and installed by the contractor.
 - b. Gallery View display shall be Samsung with size appropriate to the distance from the instructor station to the back wall. Size shall be coordinated with the District.
 - c. Gallery View display shall be mounted on the wall directly across from the instructor station. Gallery View display mount shall be Chief PDRUB.
- 10. Media Switcher
 - a. Media switcher shall be provided by the District and installed by the contractor
 - b. Media switcher shall be Extron IN1808 IPCP Q MA 70.
- 11. Audio
 - a. All components shall be provided by the District and installed by the contractor.
 - b. Ceiling loudspeakers shall be Extron FF 220T. For a typical ceiling height of 9' to 10' AFF, ceiling loudspeakers shall be spaced no more than 15' apart and 6' from a wall. Loudspeakers shall be evenly distributed throughout the ceiling as much as possible.
 - c. Ceiling microphone shall be Shure MXA920W-US. For a typical ceiling height of 9' to 10' AFF, ceiling microphone quantity shall be determined based on 30' radius coverage maximum, per microphone. Microphone/s shall be positioned to maximize coverage of instruction and student space.
- 12. Control System
 - a. Control system shall be provided by the District and installed by the contractor.
 - b. Touch panel shall be Extron TLP Pro 1025T.
 - c. Network switch for system shall be provided by the District and installed by the contractor in the AV equipment rack.
- 13. Software
 - a. Software for remote management shall be Extron Global Configurator.
- 14. Cabling and Connectors
 - a. Contractor shall provide the following:
 - i. Auxiliary HDMI input at instructor station cable cubby.
 - ii. USB extension cable from room computer at instructor station cable cubby.
 - iii. 1/8" analog audio output jack for connection to portable ALS.

Pathways and Electrical Requirements

- 1. Instructor Station Floor Box
 - a. Floor box shall be Wiremold RFBA Series floor box.
 - b. 2-each, 1-1/4" conduit stub above accessible ceiling with plastic bushing.
 - c. Power outlet shall be 20-amp, 120-volt, quad, dedicated.
- 2. Video Projector Location
 - a. Power outlet shall be 20-amp, 120-volt, duplex, dedicated.
- 3. Gallery View Display Location
 - a. Power outlet shall be 20-amp, 120-volt, duplex.

Data Requirements

- 1. Instructor Station Floor Box
 - a. 4-each, RJ45, Data

2. Video Projector
 - a. 2-each, RJ45, Data
3. Front Wall/Teaching Wall
 - a. 2-each, RJ45, Data
4. Side Walls
 - a. 2-each, RJ45, Data
5. Rear Wall
 - a. 2-each, RJ45, Data
6. Wireless Access Point
 - a. 2-each, RJ45, Data
7. Camera
 - a. 2-each, RJ45, Data

Other Rooms

Any rooms that do not fall under any of the previously mentioned types, shall be designed with close coordination with the District. Please refer to Exhibit B for standard equipment that are used within the District. Any AV systems designed for non-standard rooms using equipment from Exhibit B must still be reviewed and approved by the District prior to proceeding.



APPENDIX 28
DIVISION 28
SAFETY AND SECURITY



MiraCosta College Campus Security Camera System Standards



1. PURPOSE

The purpose of this document is to provide guidelines for the installation of Security Camera Systems (SCS) on the MiraCosta Community College District (District) campuses. This document applies to camera installations that will be connected to the primary campus security system network and will be utilized by District Campus Police (PD) for safety purposes.

2. BOARD POLICY

This standard is written in compliance with the associated Board Policy, BP 6520. Any SCS designed to be implemented by the District shall abide by all standards and board policies. It is the responsibility of the designer to ensure all the latest standards and policies are being implemented. Systems not in compliance with the standards and policies are not acceptable by the District and will not be contractually accepted until all deficiencies are corrected and full compliance can be proven.

1.1 CAMPUS SECURITY SYSTEM

- A. Overview: The Campus SCS provides the ability to monitor, manage, and provide video assessment capabilities to security personnel via remote monitoring functionality. This document covers the following elements of the Campus Security System:
 - 1. Security Camera System (SCS)
- B. District PD Dispatch Center: The primary purpose of the PD Dispatch Center is to respond to emergency calls and dispatch officers as needed in response to events. The SCS discussed in this document is deployed to enhance the operations of the Campus Police Department.
- C. Security Analysis: When electronic security enhancements are planned for any campus facility a security analysis shall be conducted. The analysis assesses the security issues that are being addressed, the operation of the facility adding the enhancements, the PD procedures for responding to events at the facility, the proper application of the SCS elements, and how those elements shall integrate to the Campus Security environment.
- D. Security Camera Intent: The deployment of security cameras on District campuses is to provide an envelope that primarily includes perimeter, building exterior and areas of congregation for monitoring purposes. Specific areas outside of this intent should be defined by District PD.

1.2 SECURITY CAMERA SYSTEM (SCS)

- A. Purpose: The SCS is designed to provide security personnel with the means to monitor, record, and review activity at strategic areas of the campuses. SCS shall provide the ability to record images received from cameras located throughout the campus in a digital format and retrieve the recorded video information in random

access mode based on parameters requested by the District.

- B. The SCS District standard is Verkada. Before any products are purchased for implementation the current version of software should be verified. Contact either District PD and/or ITS for information regarding the Verkada SCS.

- C. Environment:
 - 1. Primary Monitoring Post: Primary monitoring of cameras will be performed by security personnel via mobile software from Verkada. Back-up monitoring station will be located in PD building; however, security personnel shall not be designated for live monitoring of the SCS.

 - 2. Administration Station: System administration is managed by District ITS department with administrative workstations designated for SCS use.

 - 3. Connectivity:
 - a. Network communications for the SCS is over District's Campus Network. Coordinate connection of cameras to District Network with District ITS personnel. District shall determine if existing network resources are adequate or additional network equipment is required for each project.

 - b. SCS does not require a Directory Server or Recording Storage server. ITS and the PD shall determine if additional SCS hardware is required in the ITS Data Center to accommodate each project.

 - c. Video storage for the PD cameras is provided by Verkada Cloud Service with local storage on each individual camera and the cameras video content backed up to the Verkada Cloud Service.

 - 4. Infrastructure:
 - a. Cabling - SCS shall utilize CAT6A to connect all IP-based devices to the network. Refer to the Communications Design and Installation Guidelines for termination and routing requirements for the telecommunications cable plant.

 - b. Pathways - All cabling for the SCS shall be routed in conduit when it is in an accessible space or if it is being routed below 8' above the finished floor. All cabling routed above an accessible ceiling or inaccessible space shall utilize approved cable tray along main routes and may utilize j-hooks along secondary routes. Refer to the Communications Design and Installation Guidelines for termination and routing requirements for the telecommunications cable plant including proper NEC conduit fill ratios.

 - c. IDF Rooms - Camera cabling shall route to the nearest IDF room where it shall terminate on approved patch panels. Security cabling shall not terminate in rooms that are not designated as IT IDF/MDF spaces.

- D. Considerations before Adding Cameras to the System

1. General: The SCS is a cloud-based system, and a few items need to be considered before additional cameras are added to the system.
 2. Video Archiver Servers: Are not required.
 3. Video Storage: Contractor shall provide a calculation to properly determine the camera's on-board video storage capacity. Calculation will include the resolution of each camera, recording frames-per-second, anticipated amount of activity in each camera field of view (for recording on motion), and the number of days required to save video data. Once this calculation is completed, reviewed, and approved by District ITS, the camera can be ordered for installation.
 4. Camera and Workstation license: For each camera or workstation added to the system a device license will be required to enable operation of the device. It is recommended that each project include in the specifications the number of licenses required for all devices added to the system.
- E. Security Needs Analysis
1. Contractor shall perform a Security Needs Analysis with District PD and ITS before performing any SCS-related installation for any project.
 2. Security Needs Analysis shall include the following;
 - a. Confirm locations for installation of cameras. This shall include a review of the camera field of view, focal point of camera and identification of IDF or other area where camera cabling shall be terminated (See Camera Selection below for additional information).
 - b. Confirm camera and housing are appropriate for location of installation. For example, interior vs. exterior, vandal resistance and multi-sensor or single lens camera.
 - c. Identify any existing pathways, conduit or cable that can be reused for budget assistance.
- F. Camera Selection: The following guidance is provided to select the appropriate camera for the planned application. The type of camera required, and its function should be determined by the Security Needs Analysis.
1. Camera Resolution: The camera resolution determines the detail of the image as well as the data bandwidth and storage requirements for the camera. The camera resolutions below are provided to meet most applications on the District campuses. Special applications may require variations in these requirements.
 2. Camera Modes: Three camera modes are defined to assist in determine the proper camera selection:

- a. Detail Recognition (50-60 PPF) across the center of the horizontal field of view:
 - 1) Detail Recognition Mode: Facial recognition mode provides extremely high detailed information on objects, primarily the human face, to allow special software applications to compare the image captured by the camera with a database of known images. This mode is reserved for very high security applications. Facial recognition mode requires a camera selection that provides 50-60 PPF at the target location. Application examples would include:
 - a) Campus Main Vehicular and Pedestrian Entryways
 - b) Main building entryways and stairwell doors.
 - c) Building and Parking Structure Elevators
 - d) Parking Structure Vehicular and Pedestrian Entryways
 - e) Cash Handling Areas
 - f) Areas containing valuable assets
 - g) Emergency Phones & Surrounding Area
- b. Forensics Mode (Minimum 40 PPF across the horizontal center of the field of view):
 - 1) Forensics Mode: Forensic mode provides more detail in the image to assist in identifying detailed information in the scene. A typical application is the ability to clearly read the license number on a vehicle. Forensic mode requires a camera selection that provides 40 PPF at the target location. Application examples would include:
 - a) Parking structures
 - b) Campus Vehicle Entry Points
 - c) Public Gathering points
- c. General Activity Observation (Minimum 20 PPF across the horizontal center of the field of view):
 - 1) Observation Mode: This is the most common mode used for video observation. This provides good detail within the field of view and allows the ability to easily differentiate between objects within a scene. Observation mode requires a camera selection that provides 20 PPF at the target location. Application examples would include:
 - a) Building exterior perimeters
 - b) Campus walkways and gathering areas
 - c) Parking structure general areas
- d. Cameras shall record video at 15 frames per second (15fps), unless

- instructed otherwise by District PD or ITS.
- e. Cameras shall record alarm activated video at 30 frames per second (30fps), unless instructed otherwise by District PD or ITS. (See below)
3. Camera Storage: Alarm events will be recorded at 30 frames per second with 2 minutes pre- and post-alarm event and saved as a “Clip”. Alarm clips older than 30 days can be overwritten or programmed to be deleted to make room for newer alarm clips. Camera recording stream profile for all camera storage calculations is based on;
 - a. 30 days’ retention.
 - b. 30% motion detection.
 - c. Native resolution of the given camera.
 - d. 30 frames per second.
 - e. Variable bit rate.
 - f. H.265 compression.
 4. Low Light Areas: When cameras are to be placed in areas that may experience low or no light for periods of times the selected camera shall be equipped with an integrated IR illuminator. This will provide the camera with the ability to see and record images when adequate lighting is not provided. This is a critical element of the camera selection process as it has a significant impact on the amount of data stored on the camera when inadequate lighting is provided.
 5. Recording Protocols: Recording protocols determine the amount of storage space required per camera to save the video images for future playback. The following are guidelines to be used to implement future projects and may be modified as project needs are determined after the system has been in operation over a period of time.
 - a. Recording Modes: The information listed below is a guideline for cameras not assigned a specific recording protocol. Cameras assigned specific recording protocols shall supersede the modes listed below.
 - 1) Time Lapse mode: 2 fps (frames per second) at normal compression (CIF for conventional cameras and D1 for megapixel cameras).
 - 2) Normal Mode: 5 fps at SD. Quality setting medium-high
 - 3) Near Real-Time Mode: 8 fps at high quality compression at camera native resolution (800x600 for SD, 1280x720 for HD, 1920x1080 for SHD – typical)
 - 4) Real Time Mode: 15 fps at high quality compression. At native resolution
 - 5) Alarm, Event, Motion Detection Mode: 10 fps at high quality compression at native resolution

- 6) Critical Alarm Mode: 15 fps at high quality compression. At native resolution
 - b. Recording Periods:
 - 1) Normal Business Hours: to be determined for each facility.
 - 2) Off Normal Hours: Hours: to be determined for each facility.
 - 3) 24-hour Mode
 - c. Typical Scenarios:
 - 1) Common Areas (Hallways, Building Entrance, Perimeters)
 - a) Programmed for Normal Mode during Normal Business Hours
 - b) Programmed for Time Lapse Mode during off normal hours
 - c) During off normal hours the cameras shall switch from Time Lapse Mode to Motion Detection Mode when there is motion within view of the camera
 - 2) Enclosed Low Use Rooms
 - a) Program the cameras for Time Lapse Mode and assign to 24-Hour Time Period
 - b) Switch to Motion Detection Mode when there is activity in the rooms.
 - 3) Other protocols will be determined as cameras are assigned to specific type areas.
6. Acceptable Cameras: This selection guide should be reviewed and updated on a yearly basis as manufacturers release newer versions of cameras.
- a. Interior/Exterior High-Resolution Camera – Verkada CD62 (interior) CD62-E (exterior)
 - b. Interior/Exterior Multi-Sensor Camera – Verkada CH52-E
 - c. Interior/Exterior Pan Tilt and Zoom Cameras – Verkada CP52-E PTZ

1.3 CAMERA SPECIFICATION GUIDE

A. Dome Series Cameras

1. CD62 (E) Interior/Exterior Dome Camera by Verkada Inc.
 - a. Onboard Storage: [512GB|768GB|1TB| 2TB] – Select desired storage size for project CD62 cameras and delete non-applicable storage specs.
 - b. Sensor Resolution: 4K (3840 x 2160 pixels)
 - c. Lens Type: 3x Optical Zoom
 - d. Image Sensor: 1/2.8” Progressive CMOS

- e. Focal Length: 2.8 to 8mm
- f. Iris: P-Iris
- g. Aperture: F1.3 to F2.4
- h. Lens Distortion Correction (LDC): LDC crops the sensor field of view to deliver a rectified, undistorted output image.
- i. Field of View (FoV after LDC):
 - 1) Horizontal: 44° to 97° (40° to 87°)
 - 2) Vertical: 26° to 63° (23° to 57°)
 - 3) Diagonal: 50° to 106° (45° to 95°)
- j. IR Range: 30m / 98ft in low light
- k. Audio: Yes
- l. Resistance Rating:
 - 1) Rating IK08
 - 2) FCC
 - 3) IEC60950-1
- m. Dimensions:
 - 1) With Mount Plate:
 - a) Length: 146mm / 5.75in
 - b) Width: 146mm / 5.75in
 - c) Height: 104.3mm / 4.11in
 - 2) Without Mount Plate:
 - a) Length: 146mm / 5.75in
 - b) Width: 146mm / 5.75in
 - c) Height: 99.8mm / 3.93in
- n. Weight:
 - 1) With Mount Plate: 916g / 32.31oz
 - 2) Without Mount Plate: 776g / 27.37oz
- o. Operating Power: 11W (IEEE 802.3af PoE)
- p. Operating Temperature: -10°C to 50°C / 14°F to 122°F
- q. Operating Humidity: 0% to 90%
- r. Connectivity: Ethernet 10/100Mbps RJ-45 cable connector for Network/PoE connection

B. Multi-Sensor Cameras

1. CH52-E Multi-sensor Camera by Verkada Inc.
 - a. Onboard Storage: [1TB|2TB|4TB|8TB] – Select desired storage size for project CH52-E cameras and delete non-applicable storage specs.
 - b. Sensor Resolution: 4 x 5MP (2688 x 1944 pixels)
 - c. Lens Type: Varifocal; motorized zoom
 - d. Image Sensor: 4 x 1 / 2.8" Progressive CMOS
 - e. Focal Length: 3.7-7.7mm
 - f. Iris: N/A
 - g. Aperture: F1.9 - F2.9
 - h. Sensor Movement:
 - 1) Tilt: +0°-105° for each lens from horizon
 - 2) Pan: +/- 90° for each lens
 - 3) Rotation: +/- 90° for each lens
 - i. Lens Distortion Correction (LDC): LDC crops the sensor field of view to deliver a rectified, undistorted output image.
 - j. Field of View (FoV after LDC):
 - 1) Horizontal: 37° to 89° (35° to 82°)
 - 2) Vertical: 29° to 65° (26° to 60°)
 - 3) Diagonal: 46° to 99° (43° to 92°)
 - k. IR Range: 30m / 98ft
 - l. Audio: Not supported
 - m. Resistance:
 - 1) FCC
 - 2) CE - EN55035
 - 3) IK10
 - 4) IP67
 - n. Dimensions
 - 1) With Mount Plate:
 - a) Length: 275mm / 10.83in
 - b) Width: 275mm / 10.83in
 - c) Height: 118mm / 4.65in
 - 2) Without Mount Plate:
 - a) Length: 267mm / 10.51in

- b) Width: 267mm / 10.51in
 - c) Height: 114mm / 4.49in
 - o. Weight:
 - 1) With Mount Plate: 3436g / 121.2oz
 - 2) Without Mount Plate: 2900g / 102.29oz
 - p. Operating Power:
 - 1) With IR: IEEE 802.3bt Type 3 PoE++
 - 2) Without IR: IEEE 802.3at Type 2 PoE+
 - 3) Extended temperature range: IEEE 802.3bt Type 3 PoE++
 - q. Operating Temperature: -40°C to 50°C / -40°F to 122°F
 - r. Operating Humidity: 0% to 90%
 - s. Connectivity: Ethernet RJ-45 cable connector for network/PoE connection; 10/100 Mbps
- C. Pan Tilt and Zoom Cameras – Verkada CP52-E PTZ see Project Specifications for Technical Requirements.
- D. Camera Lenses
- 1. Provide varifocal lens compatible with selected camera to cover the field-of-view as indicated on the plan drawings.
 - 2. Provision for lens changes: Contractor shall include provision and installation of one (1) lens change per camera where necessary to provide acceptable viewing performance. Exchanged lenses shall remain the property of the Contractor.
 - 3. Contractor shall verify each location and coordinate field-of-view requirements with the District before ordering camera/lens combination. Contractor shall be responsible to select proper camera/lens combination to provide the field of view as shown on the drawings.
 - 4. Some configurations of dome camera and lens combinations may not meet field of view requirements as indicated on the plan drawings. Where this occurs notify the District to coordinate acceptable alternative.
- E. Camera Enclosure Mounting Hardware and Accessories
- 1. Provision for mounting hardware: Contractor shall include provision and installation of miscellaneous hardware and mounting extensions at each camera location to provide acceptable viewing performance.
 - 2. Ancillary Hardware shall be provided by the Contractor, if required, and shall be compatible with and comparable in strength to other attached hardware.

3. Contractor, coordinating with District PD and ITS, shall select the appropriate mounts and related accessories for the environment and include the part numbers in their proposal. Mounts shall be by Verkada. Contractor is responsible for verifying any updates to the following part numbers for common Verkada mounts and accessories:
 - a. ACC-MNT-2 Mounting Arm Kit by Verkada Inc.
 - 1) Description: Wall mounted extender arm with built-in 1.5" female NPT thread.
 - 2) Material: Aluminum Alloy
 - 3) Dimensions:
 - a) Length: 230.5mm / 9.07in
 - b) Width: 86mm / 3.39in
 - c) Height: 117mm / 4.61in
 - 4) Color: White
 - 5) Weight: 700g / 24.69oz
 - b. ACC-MNT-3 Wall Mounted L-Shaped Bracket Kit by Verkada Inc.
 - 1) Description: Compact bracket for mounting camera perpendicular to wall.
 - 2) Material: Aluminum Alloy
 - 3) Dimensions:
 - a) Length: 170mm / 6.69in
 - b) Width: 150mm / 5.91in
 - c) Height: 110mm / 4.33in
 - 4) Color: White
 - 5) Weight: 577g / 20.35oz
 - c. ACC-MNT-5 Mini Pendant Cap Mount Kit by Verkada Inc.
 - 1) Description: Two-piece threaded cap for mounting a Mini camera to 3/4" NPT threaded drop pipe. Cap piece can be removed and mounted independently with its 1.5" male NPT thread.
 - 2) Material: Aluminum Alloy
 - 3) Dimensions:
 - a) Length: 100mm / 3.94in
 - b) Width: 100mm / 3.94in
 - c) Height: 102.8mm / 4.05in

- 4) Color: Dark grey
 - 5) Weight: 240g / 8.47oz
 - 6) Included Accessories:
 - a) Fasteners
 - b) Set screw
 - c) Hex key
- d. ACC-MNT-6 Mini Camera Junction Box Mount Adapter by Verkada Inc.
- 1) Description: For mounting a Mini camera to a standard junction box.
 - 2) Material: Steel Mount Plate, Plastic Cover
 - 3) Dimensions:
 - a) Length: 130mm / 5.12in
 - b) Width: 130mm / 5.12in
 - c) Height: 7.5mm / 0.3in
 - 4) Color: Grey Mount Plate, White Plastic Cover
 - 5) Weight: 160g / 5.64oz
 - 6) Included Accessories:
 - a) Fasteners
- e. ACC-MNT-7 Angle Mount by Verkada Inc.
- 1) Description: Mounts fisheye and dome cameras 30° from wall for improved field of view.
 - 2) Material: Aluminum Alloy
 - 3) Dimensions:
 - a) Length: 155mm / 6.1in
 - b) Width: 149mm / 5.87in
 - c) Height: 82mm / 3.23in
 - 4) Color: White
 - 5) Weight: 390g / 13.76oz
 - 6) Included Accessories:
 - a) Metal mount ring
 - b) 3x countersink screws
 - c) 3x thumbscrews
 - d) Rubber plug

- f. ACC-MNT-8 Pendant Cap Mounting Adapter Kit by Verkada Inc.
 - 1) Description: Threaded cap adapter enables mounting of Indoor Dome Series, Outdoor Dome Series, Fisheye Series, and Multisensor Series cameras to hardware with 3/4" female NPT and 1.5" male NPT threads, including ACC-MNT-2 Mounting Arm Kit by Verkada Inc.
 - 2) Material: Aluminum Alloy
 - 3) Dimensions:
 - a) Length: 155mm / 6.1in
 - b) Width: 155mm / 6.1in
 - c) Height: 42mm / 1.65in
 - 4) Color: White
 - 5) Weight: 300g / 10.58oz
 - 6) Included Accessories:
 - a) Set screw
 - b) 3x thumbscrews.
- g. ACC-MNT-9 Pole Mount Adapter by Verkada Inc.
 - 1) Description: For mounting a camera to a circular pole.
 - 2) Mounting Pole Diameter: 32mm to 152.4mm / 1.25in to 6in
 - 3) Material: Steel
 - 4) Dimensions:
 - a) Length: 160mm / 6.3in
 - b) Width: 160mm / 6.3in
 - c) Height: 68mm / 2.68in
 - 5) Color: White
 - 6) Weight: 742g / 26.17oz
 - 7) Included Accessories:
 - a) Adapter plate
 - b) 2x Metal strap set
 - c) Fasteners for compatible mounts
- h. ACC-MNT-10 Corner Mount by Verkada Inc.
 - 1) Description: Versatile bracket for mounting a range of accessories and cameras on corners.
 - 2) Material: Steel

- 3) Dimensions:
 - a) Length: 190mm / 7.48in
 - b) Width: 263mm / 10.35in
 - c) Height: 170mm / 6.69in
- 4) Color: White
- 5) Weight: 1,890g / 66.67oz
- i. ACC-MNT-11 Square Junction Box
 - 1) Description: Square junction box for mounting Bullet Series cameras.
 - 2) Material: Aluminum alloy
 - 3) Dimensions:
 - a) Length: 128mm / 5.04in
 - b) Width: 128mm / 5.04in
 - c) Height: 40mm / 1.57in
 - 4) Color: White
 - 5) Weight: 303g / 10.69oz
 - 6) Included Accessories:
 - a) 2x $\frac{3}{4}$ in NPT plugs
 - b) 4x buttonhead screws
- j. ACC-CAM-SHIELD-1
 - 1) Description: Weather shield for protecting Dome Series and Fisheye Series cameras.
 - 2) Material: Steel mount plate, polycarbonate visor
 - 3) Dimensions:
 - a) Length: 192mm / 7.56in
 - b) Width: 185mm / 7.28in
 - c) Height: 78mm / 3.07in
 - 4) Color:
 - a) Black mount plate
 - b) White and black visor
 - 5) Weight: 173g / 6.1oz
 - 6) Included Accessories:
 - a) Mounting fasteners



END OF SECTION



APPENDIX 32
DIVISION 32
EXTERIOR IMPROVEMENTS

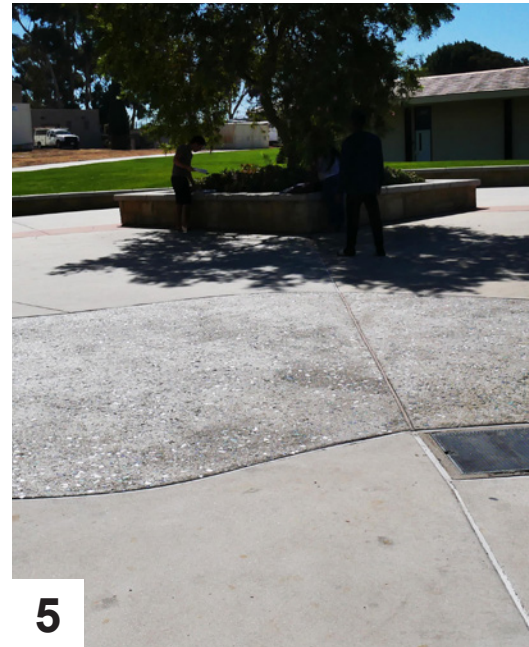
32-A / HARDSCAPE FINISHES

Hardscape Finishes Such as (but not limited to):

1. Natural Grey Sand Finish
(At all Sidewalks)
2. Grey Medium Exposed Aggregate
(At Courtyards)
3. Grey Heavy Exposed Aggregate
(At Main Plazas)



5. Seeded Agreggate Concrete Accents
- Natural Grey with...
(At Clock Tower Plaza at Oceanside campus)



6. Precast Pavers - TBD



7. Stabilized Decomposed Granite -
Sunny Side Decomposed Granite

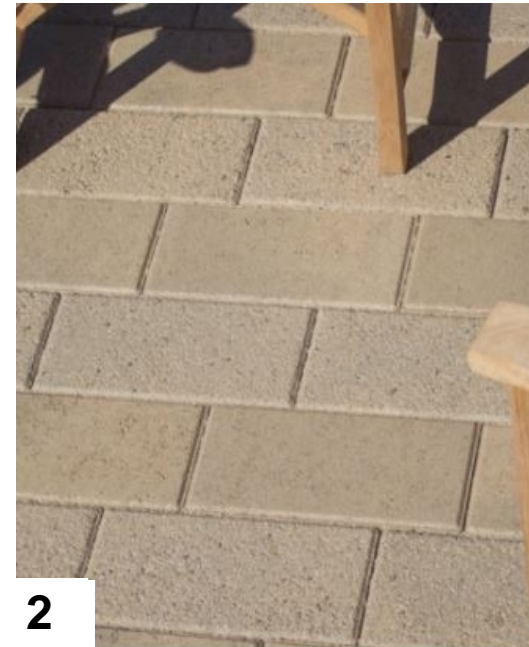


***All exterior concrete finishes shall meet or exceed the slip coefficient for exterior concrete, refer to specifications for more information**

32-B / PAVERS

**Pavers Such as
(but not limited to):**

1. Linear Pavers by Stepstone
2. Del Mar Pavers by Orco
3. Squared Pavers by Ackerstone



***All exterior concrete finishes shall meet or exceed the slip coefficient for exterior concrete, refer to specifications for more information**

32-C / CONCRETE WALLS

Wall Finishes Such as (but not limited to):

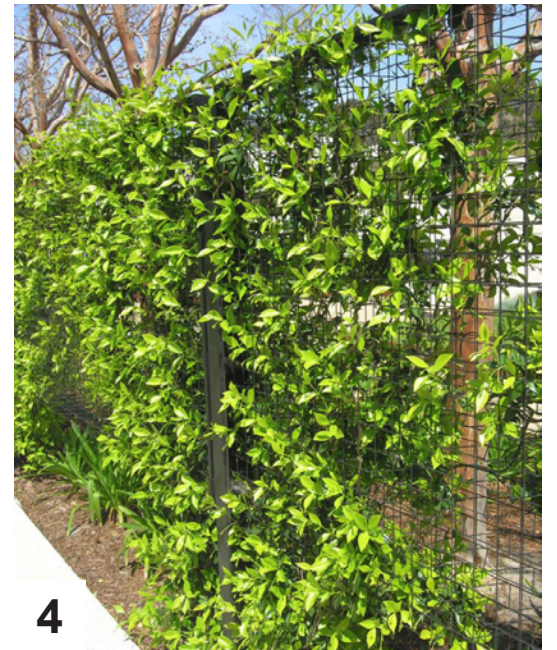
1. Natural Grey Sand Finish with built-in skateboard deterrents
2. Clock Tower & Student Center Plaza Walls - Sand finish concrete with stone veneer and natural grey sand finish concrete cap (TBD)
3. Natural Grey Board Form Concrete Wall at all new plazas



32-D / FENCING

Fences Such as (but not limited to):

1. Omega Architectural by Omega
2. Omega Eco by Omega
3. Omega 20 by Omega
4. Greenscreen Panel by Greenscreen
5. Twinbar by Metalco
6. Grigliatto by Metalco
7. Coated Chainlink Fence and Gate by Rustic Fence
8. Chainlink Fence and Gate by Pacific Fence



32-E.1 / FURNISHINGS

Bike Racks Such as (but not limited to):

1- Gridrac GR116 - 9 Bike Single Sided -
Galvanized steel - Surface
bolted/anchored

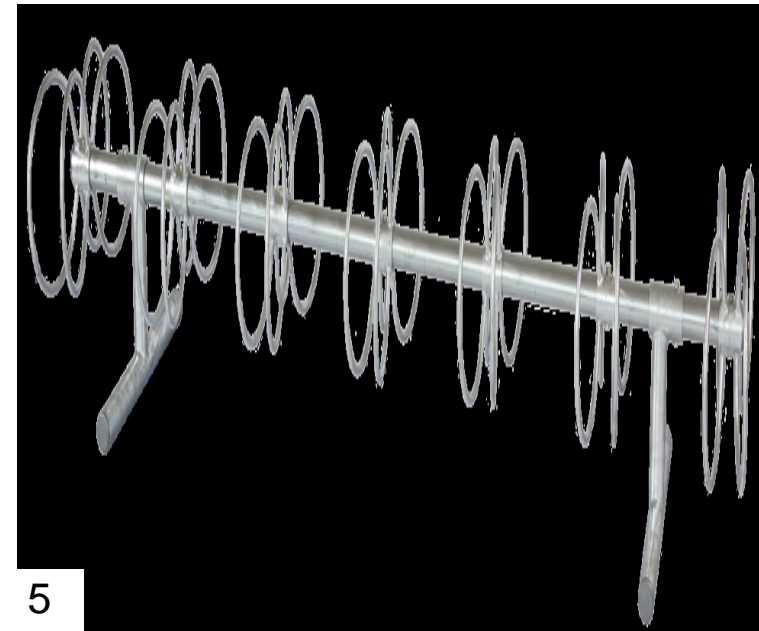
2- Freesia Bike Rack/VICTOR
STANLEY

3- Bike bollard /VICTOR
STANLEY/Model BKR-35

4- Single wide loop bike rack /VICTOR
STANLEY Model BRWS-161

5-Circle Style Bike Racks, Single and
Double Sided/ KAY

6-Commercial Bike Rack | "J" Frame
Style/ KAY



32-E.2 / FURNISHINGS

Other Furnishings Such As (but not limited to):

1. Primus Umbrella by Caravita
2. COHO Tree Grate by Urban Accessories



32-F / CANOPY TREES

Trees Such as:

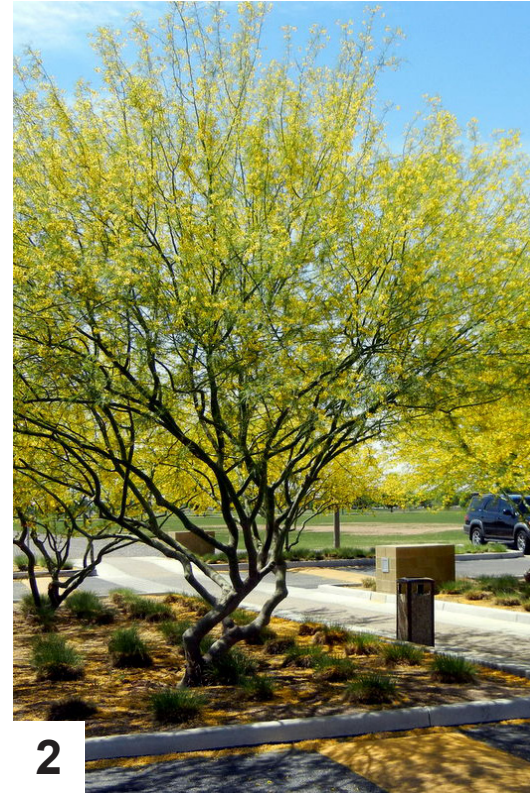
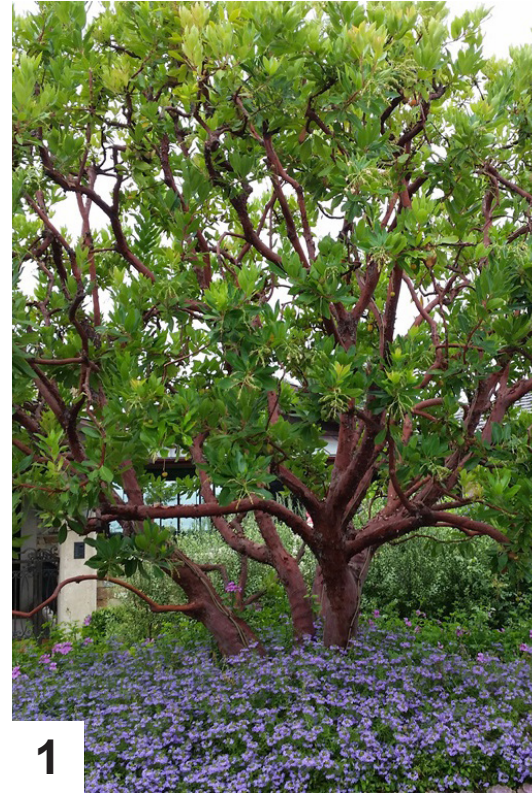
1. *Alnus rhombifolia* / White Alder
2. *Jacaranda mimosifolia* / Jacaranda
3. *Pinus canariensis* / Canary Island Pine
4. *Pinus torreyana* / Torrey Pine
5. *Quercus agrifolia* / Coast Live Oak
6. *Quercus engelmanni* / Engelmann's Oak
7. *Ulmus parvifolia* / Chinese Elm Tree



32-G / ACCENT TREES

Accent Trees Such as:

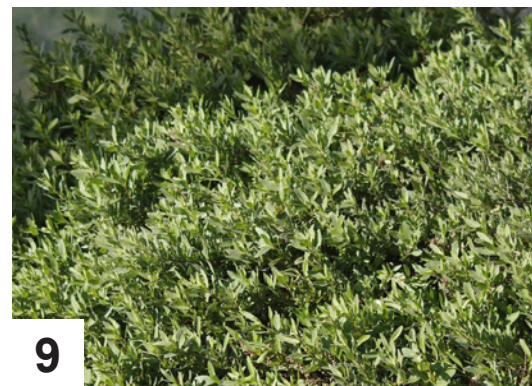
1. *Arbutus marina* / Marina Strawberry Tree
2. *Cercidium desert museum* / Desert Museum Palo Verde
3. *Cercis candensis* 'Forest Pansy' / Eastern redbud
4. *Chamaerops humilis* / Mediterrenean Fan Palm
5. *Dracaena draco* / Dragon Tree
6. *Lagerstroemia indica* 'Tuskegee' / Tuskegee Crape Myrtle
7. *Phoenix dactylifera* / Date Palm



32-H / BIOSWALE PLANTING

Plants Such as:

1. *Achillea millefolium* 'Paprika' / Paprika Yarrow
2. *Baccharis p.* "Pigeon Point" / Dwarf Coyote Brush
3. *Carex praegracilis* / California Field Sedge
4. *Carex spissa* / San Diego Sedge
5. *Chondropetalum tectorum* / Small Cape Rush
6. *Dianella caerulea* 'Cassa Blue' / Blue Flax Lily
7. *Salix lasiolepis* / Arroyo Willow
8. *Festuca mairei* / Atlas Fescue
9. *Iva hayesiana* / San Diego Poverty Weed
10. *Juncus patens* 'Elk Blue' / Elk Blue California Rush
11. *Sesleria autumnalis* / Autumn Moor Grass
12. *Myrica californica* / Pacific Wax Myrtle
13. Not Used
14. *Nasella pulchra* / Purple Neddlegrass



32-I.1 / UNDERSTORY PLANTING

Chaparral Plants*

Such as:

1. *Adenostoma fasciculatum* / Chamise
2. *Ceanothus 'dark star'* / Dark Star Ceanothus
3. *Malosma laurina* / Laurel Sumac
4. *Mimulus aurantiacus* / Bush Monkey Flower
5. *Rhamnus californica 'Eve Case'* / California Coffeberry
6. *Rhus ovata* / Sugar Bush
7. *Salvia leucophylla* / Purple Sage
8. *Yucca whippleii* / Chaparral Yucca



Coastal Sagescrub Plants*

Such as:

9. *Artemisia californica* / California Sagescrub
10. *Baccharis p. "Pigeon Point"* / Dwarf Coyote Brush
11. *Encelia californica* / Bush Sunflower
12. *Eriogonum Fasciculatum* / California Buckwheat
13. *Heteromeles arbutifolia* / Toyon
14. *Rhus Integrifolia* / Lemonade Berry
15. *Salvia apiana* / White Sage
16. *Salvia millifera* / Black Sage



*Recommended for San Elijo Campus habitat boundaries

32-I.2 / UNDERSTORY PLANTING

Southwestern Plants

Such as:

1. *Agave americana* / Century Plant
2. *Agave desmetiana* 'Variegata' / Variegated Smooth Agave
3. *Agave Shawii* / Shawii Agave
4. *Agave* 'Blue Flame' / Blue Flame Agave
5. *Echinocactus grusonii* / Barrel Cactus
6. *Hesperaloe parvifolia* / Red Yucca
7. *Senecio mandraliscae* / Blue Chalksticks
8. *Tecoma stans* 'Gold Star' / Stans Gold Star



Mediterranean Plants

Such as:

9. *Aloe arborescense* / Torch Aloe
10. *Aloe* 'Blue Elf' / Blue Elf Aloe
11. *Agave attenuata* / Fox Agave
12. *Lantana montevidensis* / Trailing Lantana
13. *Salvia leucantha* 'Midnight' / Gray Lavender Cotton
14. *Santolina chamaecyparissus* / Gray Lavender Cotton



32-J / PLANTING MULCH

Mulches Such as:

1. Medium Rock Mulch* -
Sunny Side, Size 3/4" minus
2. Small Rock Mulch* -
Sunny Side, Size 3/8" minus
3. Vegetative Mulch* - Forest Floor by
Agriserv



*Mulch to be used in all planting areas. 3" depth minimum, refer to specs for more information



MIRACOSTA COMMUNITY COLLEGE

SITWORK DESIGN STANDARDS

1. Site Grading-General Requirements

Overview:

The three campuses of the MiraCosta Community College District-Oceanside, San Elijo and the Community Learning Center or CLC-are situated on gently sloping hilltops or hillsides that have previously been developed and require clearing and grading of sites to facilitate development of new instructional buildings and support facilities. Topography and soils conditions vary between the campuses and must be taken into account through detailed investigations of conditions at each site and through the final design process.

Design Criteria:

- a. A detailed, digital topographic survey shall be prepared by the design team for each development site, typically at a scale of 1"=20' with a one foot contour interval. The survey should be supplemented with adequate field survey points to design new improvements to ADA standards.
- b. A geotechnical investigation report shall be prepared by the design team as part of the initial design phase. The report should include recommendations regarding subsurface conditions, remedial grading, groundwater, slope ratios, soils shrinkage, structural properties and infiltration data. Geotechnical reports are typically issued to bidders as reference documents for information only, designers need to incorporate specific recommendations from the report into the contract documents to make them binding on the contractor. The geotechnical engineer/engineering geologist should review the final grading plans and specifications to confirm the recommendations have been correctly interpreted and incorporated into the contract documents.
- c. As much of the three campuses has previously been developed, site clearing is a critical element of the development process. Clearing of the site should be shown on the grading plans (if minor) or on a separate site demolition plan (if significant). In addition to showing limits of clearing of surface improvements and vegetation, the plans should indicate or reference relocation of existing utilities. Locations of existing utilities should be researched thoroughly, marked out and potholed to verify locations in the immediate area of new facilities. Utility relocations may need to be phased or performed in advance to minimize impacts to other functions on campus.



- d. Final grading plans shall indicate existing and proposed grades, estimated earthwork quantities (including export/import), graded slopes, remedial grading, drainage improvements, surface improvements, horizontal and vertical controls for construction.
- e. Longitudinal grades should be 1% minimum, unpaved areas should slope at 2% minimum away from buildings and be 6 inches minimum below finish floor elevation.
- f. Site retaining walls may be SDRSD or Caltrans standard cantilever walls, gravity walls or proprietary type walls (Keystone, Loffelstein, et al). All retaining walls shall have wall drains connected to the site drainage system, CMU walls shall be waterproofed to reduce efflorescence, and walls 30 inches or taller adjacent to walkways shall have handrails in compliance with applicable codes.
- g. Designers may estimate earthwork quantities for budgetary purposes; however, project specifications should require contractors to perform their own independent earthwork estimate as part of the bidding process.
- h. Oversight of grading operations will be the responsibility of the construction manager and testing lab during construction.

2. Site Paving-General Requirements

Overview:

All three campuses utilize asphalt concrete (AC) paving extensively for roadways, driveways, and parking areas. Portland Cement Concrete (PCC) is also widely used at each campus for curbs, gutters, sidewalks, driveways, curb ramps, bus pads and other surface improvements.

Design Criteria:

- a. Structural sections for AC and PCC paving sections shall be based on the recommendations of the geotechnical report, including thickened edge sections, reinforcing, base material, and doweling into existing slabs where applicable.
- b. AC paving sections should consist of a minimum of 4 inches of AC over 12 inches minimum of aggregate base, final section to be based on the Traffic Index and subgrade R value of the location in question, as determined by the geotechnical engineer. PCC paving sections should be 4 inch minimum thickness in pedestrian areas with #4 rebar at 24 inches each way, and 6 inch minimum thickness with #5 rebar at 18 inches each way in areas subject to vehicular traffic.
- c. Weakened plane joints (or control joints) in PCC paving shall be provided at no more than 10 feet in either direction, with expansion joints at every third control joint. Joint details shall conform to the San Diego Regional Standard Drawings.
- d. Concrete pads, minimum 6 inches in thickness, shall be provided at bus stops and trash enclosures.

- e. Concrete compressive strength for curbs, gutters and sidewalks shall be 2,500 psi minimum, and 3,250 psi minimum for concrete paving, cross gutters and other flatwork subject to vehicular loads. Concrete strength for structures shall be as indicated on the details or by the engineer.
- f. Subgrade for AC and PCC pavements shall be prepared and compacted to 95% relative compaction to 12 inches deep. Remedial grading, if required, shall conform to the recommendations of the geotechnical report.
- g. Roadway and parking area striping and signage shall conform to the Caltrans Traffic Manual, MUTCD and ADA.
- h. Walkways, ramps and curb ramps along the pedestrian path(s) of travel shall conform to ADA standards and Title 24 including installation of landings, railings and 36-inch-wide detectable warning surfaces where applicable. Non-compliant curb ramps and driveways within the project limits should be replaced as part of the sitework. Accessible walkways should be kept to 4.5% longitudinal slope and 1.5% cross slope to allow for construction tolerances and still be ADA compliant. Ramps should be treated similarly with 8% maximum longitudinal slope and 1.5% maximum cross slope, and will require ADA compliant handrails and landings.

3. Water Distribution-General Requirements

Overview:

MiraCosta College's Oceanside Campus is served by two separate water systems: a domestic loop and a combination fire/irrigation loop, both private systems maintained by MCC. The domestic loop is 6" diameter, served by master water meter and backflow preventer with pressure boosted from 20 to 60-70 psi by a pump. The irrigation and fire services at Oceanside are fed from separate 8 inch loops boosted by a 50 horsepower fire pump and a smaller jockey pump for irrigation demands. There is also a master backflow at the pumps for these services.

The San Elijo Campus is served by a master domestic meter, with mains and services that branch out to serve various buildings at the campus. Similarly, a fire main and master backflow preventer connect to the public water main near the parking lot, and fire services to the individual buildings branch out from there.

The CLC campus is served by a public water main maintained by the City of Oceanside running through the central portion of the campus within an easement. Domestic, irrigation and fire services are connected to this main, as are onsite fire hydrants. The services have individual meters and backflow preventers.



Design Criteria:

- a. New water mains should be AWWA C900 PVC pipe, CL 150 min., 6" minimum in size and installed per the manufacturers recommendations. ACP water pipe is not allowed, and should be removed within project limits. Fittings are to be cast iron or ductile iron designed for water service applications. Domestic mains should be disinfected and tested after construction in accordance with local agency requirements.
- b. Sectionalizing valves should be provided at regular intervals to allow for shutdown of portions of the mains without affecting the entire campus. Resilient wedge gate valves are preferred, with standard adjustable valve cans and cast iron traffic rated lids labeled "Water".
- c. Domestic building services should be copper water pipe with a ball valve shutoff within the building to prevent tampering. Domestic services should be 2" minimum size for larger buildings, and no individual domestic backflow preventers are required except at buildings using mechanical equipment with chemical injection. Individual remote reading meters will be required on each building to track usage, reporting to the control center.
- d. Building fire services will be 4"-8" diameter. Individual building backflow preventers are not required but a Fire Department Connection (FDC) and a Post Indicator Valve (PIV) shall be installed with appropriate signage as required by code & DSA. A hard wired, alarmed tamper switch shall be installed on the PIV.
- e. Fire hydrant locations on the site shall be compliant with NFPA, California Fire Code and local fire marshal requirements. Hydrants shall be located adjacent to fire lanes and have 1-4" port and two 2-1/2" ports with concrete splash pads.
- f. New domestic mains shall be located in accordance with State Health Department criteria, generally 10 foot horizontal separation from sewer and recycle water mains.



4. Wastewater Collection-General Requirements

Overview:

MiraCosta College's Oceanside Campus is served by an extensive system of private sewer mains throughout the campus, connecting to the public sewer system at multiple locations. Buildings are connected to the mains by individual building laterals. The San Elijo Campus is connected to the public sewer system at the east side of the campus. From this point a series of gravity mains branch out to serve the buildings. The CLC campus is served by private sewer mains along the east and west sides of the site, connecting to the public sewer system at the south end. Buildings are connected to this main through individual laterals.

Design Criteria:

- a. Pipe for new sewer mains shall be PVC SDR 35 with rubber gasket joints, 8" minimum in diameter and installed in accordance with the pipe manufacturer's recommendations. Vitrified Clay Pipe (VCP) is no longer allowed.
- b. New sewer pipelines shall be designed to flow no more than half full at peak flows, with 2 fps minimum cleansing velocity. Minimum grade shall be 0.5%. Wastewater generation rates and peaking factors shall be per local agency requirements, City of Oceanside or City of Encinitas depending on the campus.
- c. Sewer manholes shall be located at 500 foot maximum intervals with 48" precast rings with T-Lock lining to reduce concrete corrosion and no interior steps. Manholes should be accessible to maintenance vehicles, but located outside traffic lanes of roadways and located outside gutters and flowlines of drainage courses. Sewer cleanouts are not an acceptable substitute for manholes on sewer mains.
- d. Sewer laterals shall be PVC and 4 inch minimum in size, with a maximum of one building per lateral. No "daisy chaining" or connecting multiple buildings to a single lateral is allowed. Each lateral shall have a two way cleanout, five feet off the building face. Buildings with long laterals shall have a sewer cleanout every 100 feet.



5. Storm Drainage-General Requirements

Overview: The Oceanside and San Elijo campuses have extensive storm drain systems that collect and convey runoff from roof drains, area drains, catch basins and curb inlets located within each campus out to natural discharge points. The CLC campus is smaller in area and generally drains on the surface out to public streets and storm drains.

Design Criteria:

- a. Storm drain facilities shall be designed to convey the 50 year storm if a surface outlet is available, and designed to convey a 100 year storm in a sump condition. Hydrologic analyses shall be in conformance with local agency requirements (either City of Oceanside or City of Encinitas). Site grading should be designed to provide a surface outlet for the 100 year storm before flooding buildings.
- b. New storm drain pipe shall be either Polyvinyl Chloride Pipe (PVC) SDR 35 or Reinforced Concrete Pipe (RCP), designed for the applicable hydraulic and loading conditions and installed per the pipe manufacturer's recommendations. RCP shall be 1350-D load minimum. Corrugated metal pipe (CMP) is not allowed, and existing CMP within the project limits should be replaced as part of the project.
- c. New mainline storm drains shall be 12 inches minimum diameter, drainage laterals and minor area drain pipes shall be 4 inches minimum diameter.
- d. Drainage structures shall be cast in place concrete, conforming to the San Diego Regional Standard Drawings. Precast concrete structures may be allowed as an alternate with the approval of the Design Engineer. Grates and other hardware shall be cast iron or galvanized steel. Traffic rated grates shall be installed in areas subject to vehicular traffic, and ADA compliant grates in areas subject to pedestrian traffic. Tamper resistant hardware may be required in areas subject to vandalism or in high traffic areas.
- e. Roof drains shall be connected directly to the drainage system, overflow drains shall spill on grade into splash blocks or similar where they are visible to maintenance personnel.
- f. Drainage should not be directed down the faces of slopes. Energy dissipaters shall be provided at outfalls where runoff is discharged at erosive velocities (>5 fps), and open channels shall be lined to prevent erosion. Storm drains on slopes shall have cutoff walls and/or anchors, as appropriate, and all culverts shall have headwalls in accordance with SDRSD.
- g. Roadways should be designed to carry the 50 year storm without overtopping the curb. Curb opening inlets shall be located to provide full interception of gutter flows, bypassing flows is acceptable only under unusual conditions. Grated catch basins are acceptable, but must be designed with a 100% debris clogging factor.
- h. Site drainage should be designed to incorporated Low Impact Development (LID) measures not only to reduce the volume and enhance the quality of runoff, but also to



increase LEED credits. LID measures may include vegetated swales, flow through planters, permeable paving, bioretention/infiltration basins or “rain gardens”. LID measures involving permanent ponds, pumps, electronics, intensive maintenance or operations processes should be avoided. LID measures shall be designed for low maintenance, vector reduction, and passage of a 100 year storm without major damage. Permanent water quality measures shall also comply with water quality regulations in effect at the time of development, the Storm Water Quality Management Plan (SWQMP) or the Water Quality Technical Report (WQTR) in effect for each campus.

- i. A Storm Water Pollution Prevention Plan (SWPPP) will be required for any project disturbing over one acre in area. Preparation by a Qualified SWPPP Developer (QSP) on the design team is the preferred method to incorporate the SWPPP into the construction documents. The contractor will be responsible for installation and maintenance of water pollution control BMPs during construction. SWPPP inspections and oversight will be performed by a Qualified SWPPP Practitioner (QSP) as a part of the construction management team.

