

# Project Manual

For

## **MCCCD, San Elijo Campus B900 Modernization**

MCCCD San Elijo, 3333 Manchester Avenue, Cardiff, CA. 92007

Bidding and Contract Requirements  
And Specifications

for the

**MiraCosta Community College**  
1 Barnard Drive, Oceanside, CA. 92056

Date: November 12, 2020

PBK Project No.: 20151

DSA Application No.: 04-119576



# MCCCD San Elijo, B900 Modernization

## MiraCosta Community College District

### Consultants:

**Architect:**

PBK  
11455 El Camino Real  
Suite 480  
San Diego, CA 92130  
Phone: (858) 695-0400


**Civil:**

Latitude 33  
9968 Hibert Street  
2<sup>ND</sup> Floor  
San Diego, CA. 92131  
Phone: (858) 875-1702

**Structural:**

Saiful Bouquet  
2020 Camino Del Rio North  
Suite 305  
San Diego, CA. 92108  
Phone: (619) 630-9199


**Structural – System Wall:**

Parron Hall Construct  
9655 Granite Ridge Drive  
Suite 100  
San Diego, CA. 92123  
Phone: (858) 737-1212


**Mechanical/Plumbing:**

P2S  
9665 Chesapeake Drive  
Suite 230  
San Diego, CA. 92123  
Phone: (619) 618-2347


**Controls Engineer:**

SC Engineers  
17075 Via Del Campo  
San Diego, CA. 92127  
Phone: (858) 946-0333


**Electrical/Fire Alarm:**

P2S  
9665 Chesapeake Drive  
Suite 230  
San Diego, CA. 92123  
Phone: (619) 618-2347


**Technology:**

P2S  
9665 Chesapeake Drive  
Suite 230  
San Diego, CA. 92123  
Phone: (619) 618-2347


**Fire Protection:**

P2S  
9665 Chesapeake Drive  
Suite 230  
San Diego, CA. 92123  
Phone: (619) 618-2347





**Security:**

Evante 360  
895 Dove Street  
Suite 300  
New Port Beach, CA. 92660  
Phone: (949) 485-1710



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Not Applicable

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**END OF DOCUMENT 00 00 10**

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## SECTION 01 10 00 SUMMARY

### 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 requirements including but not limited to:
  - 1. Project information.
  - 2. Work covered by Contract Documents.
  - 3. Phased construction.
  - 4. Work by Owner.
  - 5. Work under separate contracts.
  - 6. Future Work.
  - 7. Purchase contracts.
  - 8. Owner furnished products.
  - 9. Owner furnished, Contractor installed products.
  - 10. Access to site.
  - 11. Coordination with occupants.
  - 12. Work restrictions.
  - 13. Specification and drawing conventions.
  - 14. Miscellaneous provisions.

#### 1.3 PROJECT INFORMATION

- A. Project Identification:
  - 1. Project Location: **Miracosta Community College**  
3333 Manchester Avenue  
Cardiff, CA 92007
- B. Owner: **Miracosta Community College District**
  - 1. Owner's Representative: **Kitchell**  
1 Barnard Drive, Bldg. T120  
Oceanside, CA 92056
- C. Architect: **PBK Architects**  
11455 El Camino Real, Suite 480  
San Diego, California. 92130
- D. Consultants: Additional design professionals have been retained who have prepared designated portions of the Contract Documents. Refer to "stamp" page this project manual.

#### 1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following: The modernization of Building B900, Student Center. Work consists but is not limited to the following; Construction, replacement and renovation of new conventionally framed walls, suspended acoustical ceilings, doors, windows, casework and finishes. Replacement and

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renovation of mechanical, plumbing, electrical, technology, fire alarm and fire protection systems. Exterior improvements include the renovation of a portion of the existing clay tile roof, new skylights, paint and concrete sidewalk replacement.

## **1.5 WORK BY OWNER AND UNDER SEPARATE CONTRACTS**

- A. The Owner reserves the right to let separate contract for work outside of the scope of this Contract. Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.
- B. Owner Furnished Products (OFCI): The Owner will furnish products indicated. The work includes receiving, unloading, handling, storing, protecting, and installing Owner furnished products and making building services connections when applicable.
  - 1. Owner Furnished Products: Coordinate with Owner.

## **1.6 ACCESS TO SITE**

- A. Use of Site: Limit use of Project site to Work in areas and areas within the Contract limits indicated. Do not disturb portions of site beyond areas in which the Work is indicated.
  - 1. Limits: The drawings indicate the limits of the construction operations.
  - 2. Driveways, Walkways, and Entrances: Keep driveways, parking areas, student drop off and pick up points, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, the students, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
    - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
    - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- B. Condition of Existing Building: Maintain portions of existing building affected by construction operations in weathertight condition throughout construction period. Repair damage caused by construction operations.

## **1.7 COORDINATION WITH OCCUPANTS**

- A. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.
  - 1. Architect will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.
  - 2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
  - 3. Before limited Owner occupancy, ensure mechanical and electrical systems are fully operational, and required tests and inspections and start up procedures are successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
  - 4. Upon occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

## **1.8 WORK RESTRICTIONS**

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- A. Work Restrictions: Comply with restrictions on construction operations. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On Site Work Hours: Limit Work in the existing building to normal working hours, Monday through Friday, unless otherwise indicated. Coordinate with Owner when it is necessary to extend working hours or Work on weekends.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and after providing temporary utility services according to requirements indicated:
  - 1. Notify Owner not less than two weeks in advance of proposed utility interruptions.
  - 2. Obtain Owner's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, and Odors: Coordinate operations that result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
  - 1. Notify Owner not less than two weeks in advance of proposed disruptive operations.
  - 2. Obtain Owner's written permission before proceeding with disruptive operations.
- E. Controlled Substances, Firearms, and Explosive Devices: Use of tobacco products, controlled substances, firearms, and explosive devices on the site is not permitted.
- F. Employee Identification: Provide identification tags for Contractor personnel working on site. Require personnel to use identification tags at all times.
- G. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on site.
  - 1. Maintain list of approved screened personnel with Owner's representative.

## **1.9 SPECIFICATION AND DRAWING CONVENTIONS**

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
  - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
  - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
  - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
  - 2. Abbreviations: Materials and products are identified by abbreviations.

## **PART 2 PRODUCTS (NOT USED)**

**END OF SECTION 01 10 00**

DOCUMENT 01 25 13  
**PRODUCT OPTIONS AND SUBSTITUTIONS**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS AND PROVISIONS**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. Instructions to Bidders;
- B. General Conditions, including, without limitation, Substitutions for Specified Items; and
- C. Special Conditions.

**1.02 SUBSTITUTIONS OF MATERIALS AND EQUIPMENT**

- A. The Board of Trustees has made certain findings and approved specific materials, products, systems, services, and/or things pursuant to the exception found in Public Contract Code section 3400 (c) (2). The specific materials, products, systems, services, and/or things are all set forth in the Resolutions passed by the Board of Trustees. A list of those specific materials, products, systems, services, and/or things are included here:

<http://www.miracosta.edu/administrative/purchasing/measuremmbids.html>

- B. When not identified as a "sole-source" item, 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. Substitutions which are equal in quality, utility, and appearance to those specified may be reviewed subject to the provisions of the General Conditions.
- C. Wherever more than one manufacturer's product is specified, the first-named product is the basis for the design used in the work and the use of alternative-named manufacturers' products or substitutes may require modifications in that design. If such alternatives are proposed by Contractor and are approved by the District and/or the Architect, Contractor shall assume all costs required to make necessary revisions and modifications of the design resulting from the substitutions requested by the Contractor.
- D. When materials and equipment are specified by first manufacturer's name and product number, second manufacturer's name and "or approved



equal," supporting data for the second product, if proposed by Contractor, shall be submitted in accordance with the requirements for substitutions.

- E. The Contractor will not be allowed to substitute specified items unless the request for substitution is submitted as follows:
  - (1) District must receive any notice of request for substitution of a specified item a minimum of ten (10) calendar days prior to bid opening.
  - (2) Within 35 days after the date of the Notice of Award, the Contractor shall submit data substantiating the request(s) for all substitution(s) containing sufficient information to assess acceptability of product or system and impact on Project, including, without limitation, the requirements specified in the Special Conditions and the technical Specifications. Insufficient information shall be grounds for rejection of substitution.
- F. If the District and/or Architect, in reviewing proposed substitute materials and equipment, require revisions or corrections to be made to previously accepted Shop Drawings and supplemental supporting data to be resubmitted, Contractor shall promptly do so. If any proposed substitution is judged by the District and/or Architect to be unacceptable, the specified material or equipment shall be provided.
- G. Samples may be required. Tests required by the District and/or Architect for the determination of quality and utility shall be made at the expense of Contractor, with acceptance of the test procedure first given by the District.
- H. In reviewing the supporting data submitted for substitutions, the District and/or Architect will use for purposes of comparison all the characteristics of the specified material or equipment as they appear in the manufacturer's published data even though all the characteristics may not have been particularly mentioned in the Contract Documents. If more than two (2) submissions of supporting data are required, the cost of reviewing the additional supporting data shall be borne by Contractor, and the District will deduct the costs from the Contract Price. The Contractor shall be responsible for any re-design costs occasioned by District's acceptance and/or approval of any substitute.
- I. The Contractor shall, in the event that a substitute is less costly than that specified, credit the District with one hundred percent (100%) of the net difference between the substitute and the originally specified material. In this event, the Contractor agrees to execute a deductive Change Order to reflect that credit. In the event Contractor furnishes a material, process, or article more expensive than that specified, the difference in the cost of that material, process, or article so furnished shall be borne by Contractor.

- J. In no event shall the District be liable for any increase in Contract Price or Contract Time due to any claimed delay in the evaluation of any proposed substitute or in the acceptance or rejection of any proposed substitute.

**PART 2 – PRODUCTS Not Used.**

**PART 3 – EXECUTION Not Used.**

END OF DOCUMENT

**CHANGE ORDER REQUEST FORM**

MiraCosta Community College District  
 1 Barnard Drive  
 Oceanside, CA 92056

**COR NO.:**

**Project:**  
**Bid No.:**  
**RFI #:**

**Date:**  
**DSA File No.:**  
**DSA Appl. No.:**

Contractor hereby submits for District's review and evaluation this Change Order Request ("COR"), submitted in accordance with and subject to the terms of the Contract Documents, including Article 42 of the General Conditions. Any spaces left blank below are deemed no change to cost or time.

Contractor understands and acknowledges that documentation supporting Contractor's COR must be attached and included for District review and evaluation. Contractor further understands and acknowledges that failure to include documentation sufficient to, in District's discretion, support some or all of the COR, shall result in a rejected COR.

	<b><u>WORK PERFORMED OTHER THAN BY CONTRACTOR</u></b>	<b><u>ADD</u></b>	<b><u>DEDUCT</u></b>
(a)	<b><u>Material</u></b> (attach suppliers' invoice or itemized quantity and unit cost plus sales tax)		
(b)	<b><u>Add Labor</u></b> (attach itemized hours and rates, fully encumbered)		
(c)	<b><u>Add Equipment</u></b> (attach suppliers' invoice)		
(d)	<b><u>Subtotal</u></b>		
(e)	<b><u>Add Allowable Markup for any and all tiers of Subcontractor</u></b> , per Article 42 of General Conditions of Item (d)		
(f)	<b><u>Subtotal</u></b>		
(g)	<b><u>Add Allowable Markup for Contractor</u></b> , per Article 42 of General Conditions of Item (f)		
(h)	<b><u>Subtotal</u></b>		
(i)	<b><u>Add Bond and Insurance</u></b> , per Article 42 of General Conditions of Item (h)		
(j)	<b><u>TOTAL</u></b>		
(k)	<b><u>Time</u></b> (zero unless indicated; "TBD" not permitted)	<b>Calendar Days</b>	

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	<b><u>WORK PERFORMED BY CONTRACTOR</u></b>	<b><u>ADD</u></b>	<b><u>DEDUCT</u></b>
(a)	<b><u>Material</u></b> (attach itemized quantity and unit cost plus sales tax)		
(b)	<b><u>Add Labor</u></b> (attach itemized hours and rates, fully encumbered)		
(c)	<b><u>Add Equipment</u></b> (attach suppliers' invoice)		
(d)	<b><u>Subtotal</u></b>		
(e)	<b><u>Add Allowable Markup for Contractor</u></b> , per Article 42 of General Conditions of Item (d)		
(f)	<b><u>Subtotal</u></b>		
(g)	<b><u>Add Bond and Insurance</u></b> , per Article 42 of General Conditions of Item (f)		
(h)	<b><u>TOTAL</u></b>		
(i)	<b><u>Time</u></b> (zero unless indicated; "TBD" not permitted)	<b><u>Calendar Days</u></b>	

The undersigned Contractor approves the foregoing as to the changes, if any, to the Contract Price specified for each item, and as to the extension of time allowed, if any, for completion of the entire Work as stated herein, and agrees to furnish all labor, materials, and service, and perform all work necessary to complete any additional work specified for the consideration stated herein. Submission of sums which have no basis in fact or which Contractor knows are false are at the sole risk of Contractor and may be a violation of the False Claims Act set forth under Government Code section 12650 *et seq.* It is understood that the changes herein to the Contract shall only be effective when approved by the governing board of the District.

It is expressly understood that the value of the extra Work or changes expressly includes any and all of the Contractor's costs and expenses, direct and indirect, resulting from additional time required on the Project or resulting from delay to the Project. Contractor is not entitled to separately recover amounts for overhead or other indirect costs. Any costs, expenses, damages, or time extensions not included are deemed waived.

**SUBMITTED BY:**

Contractor:

\_\_\_\_\_  
[Name]

\_\_\_\_\_  
Date

END OF DOCUMENT

DOCUMENT 01 26 00

**CHANGES IN THE WORK**

**CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE PROVISIONS IN THE AGREEMENT, GENERAL CONDITIONS, AND SPECIAL CONDITIONS, IF USED, RELATED TO CHANGES AND/OR REQUESTS FOR CHANGES. SEE ATTACHED FORM FOR CHANGE FOR REQUESTS (CORs).**

**CHANGE ORDER REQUEST FORM**

MiraCosta Community College District  
 1 Barnard Drive  
 Oceanside, CA 92056

**COR NO.:**

**Project:**  
**Bid No.:**  
**RFI #:**

**Date:**  
**DSA File No.:**  
**DSA Appl. No.:**

Contractor hereby submits for District's review and evaluation this Change Order Request ("COR"), submitted in accordance with and subject to the terms of the Contract Documents, including Article 42 of the General Conditions. Any spaces left blank below are deemed no change to cost or time.

Contractor understands and acknowledges that documentation supporting Contractor's COR must be attached and included for District review and evaluation. Contractor further understands and acknowledges that failure to include documentation sufficient to, in District's discretion, support some or all of the COR, shall result in a rejected COR.

	<b><u>WORK PERFORMED OTHER THAN BY CONTRACTOR</u></b>	<b><u>ADD</u></b>	<b><u>DEDUCT</u></b>
(a)	<b><u>Material</u></b> (attach suppliers' invoice or itemized quantity and unit cost plus sales tax)		
(b)	<b><u>Add Labor</u></b> (attach itemized hours and rates, fully encumbered)		
(c)	<b><u>Add Equipment</u></b> (attach suppliers' invoice)		
(d)	<b><u>Subtotal</u></b>		
(e)	<b><u>Add Allowable Markup for any and all tiers of Subcontractor</u></b> , per Article 42 of General Conditions of Item (d)		
(f)	<b><u>Subtotal</u></b>		
(g)	<b><u>Add Allowable Markup for Contractor</u></b> , per Article 42 of General Conditions of Item (f)		
(h)	<b><u>Subtotal</u></b>		
(i)	<b><u>Add Bond and Insurance</u></b> , per Article 42 of General Conditions of Item (h)		
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(k)	<b><u>Time</u></b> (zero unless indicated; "TBD" not permitted)	<b>Calendar Days</b>	

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	<b><u>WORK PERFORMED BY CONTRACTOR</u></b>	<b><u>ADD</u></b>	<b><u>DEDUCT</u></b>
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(h)	<b><u>TOTAL</u></b>		
(i)	<b><u>Time</u></b> (zero unless indicated; "TBD" not permitted)	<b><u>Calendar Days</u></b>	

The undersigned Contractor approves the foregoing as to the changes, if any, to the Contract Price specified for each item, and as to the extension of time allowed, if any, for completion of the entire Work as stated herein, and agrees to furnish all labor, materials, and service, and perform all work necessary to complete any additional work specified for the consideration stated herein. Submission of sums which have no basis in fact or which Contractor knows are false are at the sole risk of Contractor and may be a violation of the False Claims Act set forth under Government Code section 12650 *et seq.* It is understood that the changes herein to the Contract shall only be effective when approved by the governing board of the District.

It is expressly understood that the value of the extra Work or changes expressly includes any and all of the Contractor's costs and expenses, direct and indirect, resulting from additional time required on the Project or resulting from delay to the Project. Contractor is not entitled to separately recover amounts for overhead or other indirect costs. Any costs, expenses, damages, or time extensions not included are deemed waived.

**SUBMITTED BY:**

Contractor:

\_\_\_\_\_  
[Name]

\_\_\_\_\_  
Date

END OF DOCUMENT

DOCUMENT 01 29 00

**APPLICATION FOR PAYMENT AND**  
**CONDITIONAL AND UNCONDITIONAL WAIVER AND RELEASE FORMS**

**CONTRACTOR SHALL COMPLY WITH ALL PROVISIONS IN THE GENERAL  
CONDITIONS RELATED TO APPLICATIONS FOR PAYMENT AND/OR PAYMENTS.**



**CONDITIONAL WAIVER AND RELEASE  
ON PROGRESS PAYMENT  
(CIVIL CODE SECTION 8132)**

NOTICE: THIS DOCUMENT WAIVES THE CLAIMANT'S LIEN, STOP PAYMENT NOTICE, AND PAYMENT BOND RIGHTS EFFECTIVE ON RECEIPT OF PAYMENT. A PERSON SHOULD NOT RELY ON THIS DOCUMENT UNLESS SATISFIED THAT THE CLAIMANT HAS RECEIVED PAYMENT.

Name of Claimant: \_\_\_\_\_

Name of Customer: \_\_\_\_\_

Job Location: \_\_\_\_\_

Owner: \_\_\_\_\_

Through Date: \_\_\_\_\_

**Conditional Waiver and Release**

This document waives and releases lien, stop payment notice, and payment bond rights the claimant has for labor and service provided, and equipment and material delivered, to the customer on this job through the Through Date of this document. Rights based upon labor or service provided, or equipment or material delivered, pursuant to a written change order that has been fully executed by the parties prior to the date that this document is signed by the claimant, are waived and released by this document, unless listed as an Exception below. This document is effective only on the claimant's receipt of payment from the financial institution on which the following check is drawn:

Maker of Check: \_\_\_\_\_

Amount of Check: \$ \_\_\_\_\_

Check Payable to: \_\_\_\_\_

**Exceptions**

This document does not affect any of the following:

- (1) Retentions.
- (2) Extras for which the claimant has not received payment.
- (3) The following progress payments for which the claimant has previously given a conditional waiver and release but has not received payment:

Date(s) of waiver and release: \_\_\_\_\_

Amount(s) of unpaid progress payment(s): \$ \_\_\_\_\_

- (4) Contract rights, including (A) a right based on rescission, abandonment, or breach of contract, and (B) the right to recover compensation for work not compensated by the payment.

Claimant's Signature: \_\_\_\_\_

Claimant's Title: \_\_\_\_\_

Date of Signature: \_\_\_\_\_

**UNCONDITIONAL WAIVER AND RELEASE  
ON PROGRESS PAYMENT  
(CIVIL CODE SECTION 8134)**

**NOTICE TO CLAIMANT:** THIS DOCUMENT WAIVES AND RELEASES LIEN, STOP PAYMENT NOTICE, AND PAYMENT BOND RIGHTS UNCONDITIONALLY AND STATES THAT YOU HAVE BEEN PAID FOR GIVING UP THOSE RIGHTS. THIS DOCUMENT IS ENFORCEABLE AGAINST YOU IF YOU SIGN IT, EVEN IF YOU HAVE NOT BEEN PAID. IF YOU HAVE NOT BEEN PAID, USE A CONDITIONAL WAIVER AND RELEASE FORM.

Name of Claimant: \_\_\_\_\_

Name of Customer: \_\_\_\_\_

Job Location: \_\_\_\_\_

Owner: \_\_\_\_\_

Through Date: \_\_\_\_\_

**Unconditional Waiver and Release**

This document waives and releases lien, stop payment notice, and payment bond rights the claimant has for labor and service provided, and equipment and material delivered, to the customer on this job through the Through Date of this document. Rights based upon labor or service provided, or equipment or material delivered, pursuant to a written change order that has been fully executed by the parties prior to the date that this document is signed by the claimant, are waived and released by this document, unless listed as an Exception below. The claimant has received the following progress payment: \$\_\_\_\_\_

**Exceptions**

This document does not affect any of the following:

- (1) Retentions.
- (2) Extras for which the claimant has not received payment.
- (3) Contract rights, including (A) a right based on rescission, abandonment, or breach of contract, and (B) the right to recover compensation for work not compensated by the payment.

Claimant's Signature: \_\_\_\_\_

Claimant's Title: \_\_\_\_\_

Date of Signature: \_\_\_\_\_

**CONDITIONAL WAIVER AND RELEASE  
ON FINAL PAYMENT  
(CIVIL CODE SECTION 8136)**

**NOTICE:** THIS DOCUMENT WAIVES THE CLAIMANT'S LIEN, STOP PAYMENT NOTICE, AND PAYMENT BOND RIGHTS EFFECTIVE ON RECEIPT OF PAYMENT. A PERSON SHOULD NOT RELY ON THIS DOCUMENT UNLESS SATISFIED THAT THE CLAIMANT HAS RECEIVED PAYMENT.

Name of Claimant: \_\_\_\_\_

Name of Customer: \_\_\_\_\_

Job Location: \_\_\_\_\_

Owner: \_\_\_\_\_

**Conditional Waiver and Release**

This document waives and releases lien, stop payment notice, and payment bond rights the claimant has for labor and service provided, and equipment and material delivered, to the customer on this job. Rights based upon labor or service provided, or equipment or material delivered, pursuant to a written change order that has been fully executed by the parties prior to the date that this document is signed by the claimant, are waived and released by this document, unless listed as an Exception below. This document is effective only on the claimant's receipt of payment from the financial institution on which the following check is drawn:

Maker of Check: \_\_\_\_\_

Amount of Check: \$ \_\_\_\_\_

Check Payable to: \_\_\_\_\_

**Exceptions**

This document does not affect any of the following: \_\_\_\_\_

Disputed claims for extras in the amount of: \$ \_\_\_\_\_

Claimant's Signature: \_\_\_\_\_

Claimant's Title: \_\_\_\_\_

Date of Signature: \_\_\_\_\_

**UNCONDITIONAL WAIVER AND RELEASE  
ON FINAL PAYMENT  
(CIVIL CODE SECTION 8138)**

**NOTICE TO CLAIMANT:** THIS DOCUMENT WAIVES AND RELEASES LIEN, STOP PAYMENT NOTICE, AND PAYMENT BOND RIGHTS UNCONDITIONALLY AND STATES THAT YOU HAVE BEEN PAID FOR GIVING UP THOSE RIGHTS. THIS DOCUMENT IS ENFORCEABLE AGAINST YOU IF YOU SIGN IT, EVEN IF YOU HAVE NOT BEEN PAID. IF YOU HAVE NOT BEEN PAID, USE A CONDITIONAL WAIVER AND RELEASE FORM.

Name of Claimant: \_\_\_\_\_

Name of Customer: \_\_\_\_\_

Job Location: \_\_\_\_\_

Owner: \_\_\_\_\_

**Unconditional Waiver and Release**

This document waives and releases lien, stop payment notice, and payment bond rights the claimant has for all labor and service provided, and equipment and material delivered, to the customer on this job. Rights based upon labor or service provided, or equipment or material delivered, pursuant to a written change order that has been fully executed by the parties prior to the date that this document is signed by the claimant, are waived and released by this document, unless listed as an Exception below. The claimant has been paid in full.

**Exceptions**

This document does not affect any of the following: \_\_\_\_\_

Disputed claims for extras in the amount of: \$ \_\_\_\_\_

Claimant's Signature: \_\_\_\_\_

Claimant's Title: \_\_\_\_\_

Date of Signature: \_\_\_\_\_

DOCUMENT 01 31 19

**PROJECT MEETINGS**

**PART 1 – GENERAL**

**1.01 RELATED DOCUMENTS AND PROVISIONS:**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. General Conditions; and
- B. Special Conditions.

**1.02 PROGRESS MEETINGS:**

- A. PMO shall schedule and hold regular weekly progress meetings after a minimum of one week's prior written notice of the meeting date and time to all Invitees as indicated below.
- B. Location: PMO's field office.
- C. The Contractor shall notify and invite the following entities ("Invitees"):
  - (1) District Representative.
  - (2) Contractor.
  - (3) Contractor's Project Manager.
  - (4) Contractor's Superintendent.
  - (5) Subcontractors, as appropriate to the agenda of the meeting.
  - (6) Suppliers, as appropriate to the agenda of the meeting.
  - (7) Construction Manager, if any.
  - (8) Architect
  - (9) Engineer(s), if any and as appropriate to the agenda of the meeting.
  - (10) Others, as appropriate to the agenda of the meeting.
- D. The District's, the Architect's, and/or an engineer's Consultants will attend at their discretion, in response to the agenda.

- E. The District representative, the PMO, and/or another District Agent shall take and distribute meeting notes to attendees and other concerned parties. If exceptions are taken to anything in the meeting notes, those exceptions shall be stated in writing to the District within five (5) working days following District's distribution of the meeting notes.

### **1.03 PRE-INSTALLATION/PERFORMANCE MEETING:**

- A. Contractor shall schedule a meeting prior to the start of each of the following portions of the Work: cutting and patching of plaster and roofing, and other weather-exposed and moisture-resistant products. Contractor shall invite all Invitees to this meeting, and others whose work may affect or be affected by the quality of the cutting and patching work.
- B. Contractor shall review in detail prior to this meeting, the manufacturer's requirements and specifications, applicable portions of the Contract Documents, Shop Drawings, and other submittals, and other related work. At this meeting, invitees shall review and resolve conflicts, incompatibilities, or inadequacies discovered or anticipated.
- C. Contractor shall review in detail Project conditions, schedule, requirements for performance, application, installation, and quality of completed Work, and protection of adjacent Work and property.
- D. Contractor shall review in detail means of protecting the completed Work during the remainder of the construction period.

### **PART 2 - PRODUCTS Not Used.**

### **PART 3 - EXECUTION Not Used.**

END OF DOCUMENT



DOCUMENT 01 31 50

**CONTRACTOR'S REQUEST FOR INFORMATION**

**PART 1 - GENERAL**

**1.01 SUMMARY**

This section covers general requirements for Contractor's Requests for Information (RFI).

- A. The Contractor will use Prolog Converge to prepare and submit requests for information unless otherwise instructed by the District.
- B. Related Sections:
  - (1) General and Supplementary Conditions for changes in the Work.
  - (2) Section 01 31 19: Progress Meetings
  - (3) Section 01 33 00: Submittals

**1.02 RFI'S**

- A. Submit a Request for Information to the District when:
  - (1) An unforeseen condition occurs.
  - (2) Questions regarding information in the Contract Documents that are not internal to the Contractor arise.
  - (3) Information not found in the Contract Documents is required.
- B. All issues requiring clarification must be submitted as an RFI immediately. When possible, request such clarification either verbally or in writing at the next scheduled Project meeting. When the RFI is answered at the Project meeting, number the RFI and enter the response into the meeting minutes.
  - (1) When the urgency of the need or the complexity of the item makes clarification at the next scheduled Project meeting impractical, prepare and submit a formal written RFI to the District. Whenever possible, attempt to resolve potential RFI questions with Architect and/or PMO verbally, then submit confirming RFIs to document any resolved changes.

- C. RFIs shall be submitted within a reasonable time frame so as not to interfere with or impede the progress of the Work. The Contractor shall make every effort to keep the number of RFIs to a minimum. ~~If the number of RFIs becomes unwieldy, the District may require the Contractor to abandon the RFI process and submit requests as either submittals, substitutions, or requests for change.~~
- D. When the response to an RFI effects the cost or time duration of the project, notify the District in accordance with the General Conditions at the time of the submittal. Notification shall occur prior to commencing such work, so that the change order process can be initiated.
- (1) At time of submittal of the RFI, notify the District to the time available before the response will cause a time or cost impact to the Project.
  - (2) An answered RFI shall not be construed as approval to perform additional work.
- E. Form of Submittal:
- (1) Submit a legible written request as approved in advance by the District. Each request shall include the following information:
    - a. Project name, as listed on the Contract Documents, and District Project/Bid Number
    - b. Date
    - c. RFI number
    - d. Name, address, telephone and fax number of the Contractor
    - e. Number and title of affected Specification Section(s)
    - f. Drawing numbers and detail numbers as appropriate
    - g. Clear, concise explanation of information or clarification requested
    - h. Blank, lined spaces for District's response.
    - i. Signature block for District.
  - (2) Mark each page of each RFI attachment in the lower right corner with the RFI number.
  - (3) Number submitted RFIs consecutively
  - (4) Sign and stamp all RFI forms. RFIs from subcontractor or material suppliers shall be submitted through the Contractor. Contractor shall review all such information request prior to submitting to the District.
- F. RFIs not meeting the requirements of this Section will not be answered and any consequential impact on the project shall be the sole

responsibility of the Contractor. Unanswered RFIs will be returned with a stamp or notification "Not Reviewed."

- G. RFI Log: Contractor shall maintain and update the log weekly and furnish to the District when requested. The log shall contain the following minimum information:
  - (1) RFI number
  - (2) Date submitted
  - (3) Brief description of content or subject
  - (4) Date answered
- H. Allow a minimum of five (5) working days for review and response. The response time will be increased if more information is required, when the RFI is submitted out of sequence, or if in the opinion of the District, more time is required to answer the RFI.

### **1.03 QUALITY ASSURANCE**

- A. Carefully review the Contract Documents before submitting a RFI to the District. Verify that the information requested is not indicated in the Contract Documents or cannot be determined from a careful review.
  - (1) The District may not answer RFIs for information that is readily available in the Contract Documents.
- B. RFIs requesting clarification of coordination issues, shall include the Contractor's suggested solution as an attachment to the RFI.
  - (1) Such coordination issues include, but are not limited to, pipe and duct routing, clearances, specific locations of work shown diagrammatically, and similar items.
  - (2) Provide scale drawings or sketches indicating the proposed solution.
  - (3) RFIs which do not include a suggested solution will not be answered.
- C. Do not use RFIs for the following:
  - (1) To request approval of submittals.
  - (2) To request approval of substitutions.

- (3) To request changes to the Contract Documents and to confirm action taken by the Contractor for requested changes/substitutions to the Contract Documents.

PART 2 – PRODUCTS (Not Applicable)

PART 3 – EXECUTION (Not Applicable)

END OF  
SECTION

DOCUMENT 01 32 13

**SCHEDULING OF WORK**

**PART 1 – GENERAL**

**1.01 RELATED DOCUMENTS AND PROVISIONS**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. General Conditions;
- B. Special Conditions;
- C. Summary of Work; and
- D. Submittals.

**1.02 SECTION INCLUDES**

- A. Scheduling of Work under this Contract shall be performed by Contractor in accordance with requirements of this Section.
  - (1) Development of schedule, monthly payment requests, and project status reporting requirements of the Contract shall employ computerized Critical Path Method ("CPM") scheduling ("CPM Schedule").
  - (2) CPM Schedule shall portray all significant activities of the project including design activities, jurisdictional approvals, each trade or operation and major materials, submittals of shop drawings, equipment data, procurement of materials, civic art installation if necessary, required approvals by the District as well as other permitting agencies such as DSA, inspections and testing, commissioning, and project start-up.
  - (3) Submit schedules and reports as specified in the General Conditions.
- B. Upon Award of Contract, Contractor shall immediately commence development of Initial and Original CPM Schedules to ensure compliance with CPM Schedule submittal requirements.

### **1.03 CONSTRUCTION SCHEDULE**

- A. Within fourteen (14) calendar days after the date of Award of the Contract, and before request for first progress payment, the Contractor shall prepare and submit to the PMO a construction progress schedule conforming to the Milestone Schedule below.
- B. The Construction Schedule shall be continuously updated, and an updated schedule shall be submitted with each application for progress payment. Each revised schedule shall indicate the work actually accomplished during the previous period and the schedule for completion of the remaining work.

### **1.04 QUALIFICATIONS**

- A. Contractor shall employ experienced scheduling personnel qualified to use the latest version of [i.e., Primavera Project Planner]. Experience level required is set forth below. Contractor may employ such personnel directly or may employ a consultant for this purpose.
  - (1) The written statement shall identify the individual who will perform CPM scheduling.
  - (2) Capability and experience shall be verified by description of construction projects on which individual has successfully applied computerized CPM.
  - (3) Required level of experience shall include at least two (2) projects of similar nature and scope with value not less than three fourths ( $\frac{3}{4}$ ) of the Total Bid Price of this Project. The written statement shall provide contact persons for referenced projects with current telephone and address information.
- B. District reserves the right to approve or reject Contractor's scheduler or consultant at any time. District reserves the right to refuse replacing of Contractor's scheduler or consultant, if District believes replacement will negatively affect the scheduling of Work under this Contract.

### **1.05 GENERAL**

- A. Progress Schedule shall be based on and incorporate milestone and completion dates specified in Contract Documents.
- B. Overall time of completion and time of completion for each milestone shown on Progress Schedule shall adhere to times in the Contract, unless an earlier (advanced) time of completion is requested by Contractor and agreed to by District. Any such agreement shall be formalized by a Change Order.

- (1) District is not required to accept an early completion schedule, i.e., one that shows an earlier completion date than the Contract Time.
  - (2) Contractor shall not be entitled to extra compensation in event agreement is reached on an earlier completion schedule and Contractor completes its Work, for whatever reason, beyond completion date shown in its early completion schedule but within the Contract Time.
  - (3) A schedule showing the work completed in less than the Contract Time, and that has been accepted by District, shall be considered to have Project Float. The Project Float is the time between the scheduled completion of the work and the Completion Date. Project Float is a resource available to both District and the Contractor.
- C. Ownership Project Float: Neither the District nor Contractor owns Project Float. The Project owns the Project Float. As such, liability for delay of the Completion Date rests with the party whose actions, last in time, actually cause delay to the Completion Date.
- (1) For example, if Party A uses some, but not all of the Project Float and Party B later uses remainder of the Project Float as well as additional time beyond the Project Float, Party B shall be liable for the time that represents a delay to the Completion Date.
  - (2) Party A would not be responsible for the time since it did not consume the entire Project Float and additional Project Float remained; therefore, the Completion Date was unaffected by Party A.
- D. Progress Schedule shall be the basis for evaluating job progress, payment requests, and time extension requests. Responsibility for developing Contract CPM Schedule and monitoring actual progress as compared to Progress Schedule rests with Contractor.
- E. Failure of Progress Schedule to include any element of the Work, or any inaccuracy in Progress Schedule, will not relieve Contractor from responsibility for accomplishing the Work in accordance with the Contract. District's acceptance of schedule shall be for its use in monitoring and evaluating job progress, payment requests, and time extension requests and shall not, in any manner, impose a duty of care upon District, or act to relieve Contractor of its responsibility for means and methods of construction.
- F. Software: Use **P6 (Primavera) or District-approved equal**. Such software shall be compatible with Windows operating system. Contractor shall transmit contract file to District on compact disk at times requested by District.

- G. Transmit each item under the form approved by District.
  - (1) Identify Project with District Contract number and name of Contractor.
  - (2) Provide space for Contractor's approval stamp and District's review stamps.
  - (3) Submittals received from sources other than Contractor will be returned to the Contractor without District's review.

#### **1.06 INITIAL CPM SCHEDULE**

- A. Initial CPM Schedule submitted for review at the pre-construction conference shall serve as Contractor's schedule for up to ninety (90) calendar days after the Notice to Proceed.
- B. Indicate detailed plan for the Work to be completed in first ninety (90) days of the Contract; details of planned mobilization of plant and equipment; sequence of early operations; procurement of materials and equipment. Show Work beyond ninety (90) calendar days in summary form.
- C. Initial CPM Schedule shall be time scaled.
- D. Progress Payment Applications shall be returned to the Contractor without action taken by the District in the event the Contractor does not comply with this Specification Section. Submittal and acceptance of the Initial CPM Schedule in compliance with all Contract Document requirements shall be a condition precedent to the first progress payment. Use of Initial CPM Schedule for progress payments shall not exceed ninety (90) calendar days.
- E. District and Contractor shall meet to review and discuss the Initial CPM Schedule within seven (7) calendar days after it has been submitted to District.
  - (1) District's review and comment on the schedule shall be limited to Contract conformance (with sequencing, coordination, and milestone requirements).
  - (2) Contractor shall make corrections to schedule necessary to comply with Contract requirements and shall adjust schedule to incorporate any missing information requested by District. Contractor shall resubmit Initial CPM Schedule if requested by District.
- F. If, during the first ninety (90) days after Notice to Proceed, the Contractor is of the opinion that any of the Work included on its Initial CPM Schedule has been impacted, the Contractor shall submit to District a written Time Impact



Evaluation ("TIE") in accordance with Article 1.12 of this Section. The TIE shall be based on the most current update of the Initial CPM Schedule.

#### **1.07 ORIGINAL CPM SCHEDULE**

- A. Submit a detailed proposed Original CPM Schedule presenting an orderly and realistic plan for completion of the Work in conformance with requirements as specified herein.
- B. Progress Schedule shall include or comply with following requirements:
  - (1) No activity on schedule shall have duration longer than fifteen (15) work days, with exception of submittal, approval, fabrication and procurement activities, unless otherwise approved by District.
    - (a) Activity durations shall be total number of actual work days required to perform that activity.
  - (2) Each activity in the schedule shall include the following information: Activity Designation/Number – (Description Label or Name), Duration, Calendar ID, Early start date, Late start date, Early finish date, Late finish time, Identification of activities which comprise the critical path for completion, and Total float; and milestone completion dates, if any.
  - (3) District furnished materials and equipment, if any, identified as separate activities.
  - (4) Activities for maintaining Project Record Documents.
  - (5) Dependencies (or relationships) between activities.
  - (6) Processing/approval of submittals and shop drawings for all material and equipment required per the Contract. Activities that are dependent on submittal acceptance or material delivery shall not be scheduled to start earlier than expected acceptance or delivery dates.
    - (a) Include time for submittals, re-submittals and reviews by District. Coordinate with accepted schedule for submission of Shop Drawings, samples, and other submittals.
    - (b) Contractor shall be responsible for all impacts resulting from re-submittal of Shop Drawings and submittals.
  - (7) Procurement of major equipment, through receipt and inspection at jobsite, identified as separate activity.

- (a) Include time for fabrication and delivery of manufactured products for the Work.
  - (b) Show dependencies between procurement and construction.
- (8) Activity description; what Work is to be accomplished and where.
- (9) Responsibility code for each activity corresponding to Contractor or Subcontractor responsible for performing the Work.
- (10) Identify the activities which constitute the controlling operations or critical path. No more than twenty-five (25%) of the activities shall be critical or near critical. Near critical is defined as float in the range of one (1) to (10) days.
- (11) Thirty (30) calendar days for developing punch list(s), completion of punch-list items, and final clean up for the Work or any designated portion thereof. No other activities shall be scheduled during this period.
- (12) Interface with the work of other contractors, District, and agencies such as, but not limited to, utility companies.
- (13) Show detailed Subcontractor Work activities. In addition, and upon District request, furnish copies of Subcontractor schedules upon which CPM was built.
  - (a) Also furnish for each Subcontractor, as determined by District, submitted on Subcontractor letterhead, a statement certifying that Subcontractor concurs with Contractor's Original CPM Schedule and that Subcontractor's related schedules have been incorporated, including activity durations and key milestones.
  - (b) Subcontractor schedules shall be independently derived and not a copy of Contractor's schedule.
  - (c) In addition to Contractor's schedule and resource loading, obtain from electrical, mechanical, and plumbing Subcontractors, and other Subcontractors as required by District, productivity calculations common to their trades, such as units per person day, feet of pipe per day per person, feet of wiring per day per person, and similar information.
  - (d) Furnish schedule for Contractor/Subcontractor CPM schedule meetings which shall be held prior to submission of Original CPM schedule to District. District shall be permitted to attend scheduled meetings as an observer.

- (14) Activity durations shall be in Work days.
  - (15) Submit with the schedule a list of anticipated non-Workdays, such as weekends and holidays. The Progress Schedule shall exclude in its Workday calendar all non-Work days on which Contractor anticipates critical Work will not be performed.
  - (16) Seasonal weather conditions shall be considered and included in the planning and scheduling of work influenced by high or low ambient temperatures and/or precipitation to ensure completion of all Work within the Contract Time. Seasonal weather conditions shall be determined by an assessment of average historical climate conditions based upon the preceding ten (10) year records published for the locality by the National Ocean and Atmospheric Administration (NOAA) and entitled, "Local Climatological Data – Oceanside, California." Allowances for rain days and other seasonal weather conditions shall be reflected in the form of activity at the end of the project for the full amount of allowances over the length of the project. The weather activity will not be concurred with any other activity. A minimum amount of working day allowances over the length of the project is may be defined within the Supplementary Conditions. All delays caused by weather shall be documented by the Contractor in the form of a delay request.
- C. Original CPM Schedule Review Meeting: Contractor shall, within sixty (45) days from the Notice to Proceed date, meet with District to review the Original CPM Schedule submittal.
- (1) Contractor shall have its Project Manager, Project Superintendent, Project Scheduler, and key Subcontractor representatives, as required by District, in attendance. The meeting will take place over a continuous one (1) day period.
  - (2) District's review will be limited to submittal's conformance to Contract requirements including, but not limited to, coordination requirements. However, review may also include:
    - (a) Clarifications of Contract Requirements.
    - (b) Directions to include activities and information missing from submittal.
    - (c) Requests to Contractor to clarify its schedule.
  - (3) Within five (5) days of the Schedule Review Meeting, Contractor shall respond in writing to all questions and comments expressed by District at the Meeting.

## 1.08 ADJUSTMENTS TO CPM SCHEDULE

- A. Adjustments to Original CPM Schedule: Contractor shall have adjusted the Original CPM Schedule submittal to address all review comments from original CPM Schedule review meeting and resubmit network diagrams and reports for District's review.
- (1) District, within ten (10) days from date that Contractor submitted the revised schedule, will either:
    - (a) Accept schedule activities as submitted, or
    - (b) Advise Contractor in writing to review any part or parts of schedule which either do not meet Contract requirements or are unsatisfactory for District to monitor Project's progress, resources, and status or evaluate monthly payment request by Contractor.
  - (2) District may accept schedule with conditions that the first monthly CPM Schedule update be revised to correct deficiencies identified.
  - (3) When schedule is accepted, it shall be considered the "Original CPM Schedule" which will then be immediately updated to reflect the current status of the work.
  - (4) District reserves right to require Contractor to adjust, add to, or clarify any portion of schedule which may later be discovered to be insufficient for monitoring of Work or approval of partial payment requests. No additional compensation will be provided for such adjustments, additions, or clarifications.
- B. Acceptance of Contractor's schedule by District will be based solely upon schedule's compliance with Contract requirements.
- (1) By way of Contractor assigning activity durations and proposing sequence of Work, Contractor agrees to utilize sufficient and necessary management and other resources to perform work in accordance with the schedule.
  - (2) Upon submittal of schedule update, updated schedule shall be considered "current" CPM Schedule.
  - (3) Submission of Contractor's schedule to District shall not relieve Contractor of total responsibility for scheduling, sequencing, and pursuing Work to comply with requirements of Contract Documents, including adverse effects such as delays resulting from ill-timed Work.

- C. Submittal of Original CPM Schedule, and subsequent schedule updates, shall be understood to be Contractor's representation that the Schedule meets requirements of Contract Documents and that Work shall be executed in sequence indicated on the schedule.
- D. Contractor shall distribute Original CPM Schedule to Subcontractors for review and written acceptance, which shall be noted on Subcontractors' letterheads to Contractor and transmitted to District for the record.

#### **1.09 MONTHLY CPM SCHEDULE UPDATE SUBMITTALS**

- A. Following acceptance of Contractor's Original CPM Schedule, Contractor shall monitor progress of Work and adjust schedule each month to reflect actual progress and any anticipated changes to planned activities.
  - (1) Each schedule update submitted shall be complete, including all information requested for the Original CPM Schedule submittal.
  - (2) Each update shall continue to show all Work activities including those already completed. These completed activities shall accurately reflect "as built" information by indicating when activities were actually started and completed.
- B. A meeting will be held on approximately the twenty-fifth (25th) of each month to review the schedule update submittal and progress payment application.
  - (1) At this meeting, at a minimum, the following items will be reviewed: Percent (%) complete of each activity; Time Impact Evaluations for Change Orders and Time Extension Request; actual and anticipated activity sequence changes; actual and anticipated duration changes; and actual and anticipated Contractor delays.
  - (2) These meetings are considered a critical component of overall monthly schedule update submittal and Contractor shall have appropriate personnel attend. At a minimum, these meetings shall be attended by Contractor's General Superintendent and Scheduler.
  - (3) Contractor shall plan on the meeting taking no less than four (4) hours.
- C. Within five (5) working days after monthly schedule update meeting, Contractor shall submit the updated CPM Schedule update.
- D. Within five (5) workdays of receipt of above noted revised submittals, District will either accept or reject monthly schedule update submittal.

- (1) If accepted, percent (%) complete shown in monthly update will be basis for Application for Payment by the Contractor. The schedule update shall be submitted as part of the Contractor's Application for Payment.
  - (2) If rejected, update shall be corrected and resubmitted by Contractor before the Application for Payment is submitted.
- E. Neither updating, changing or revising of any report, curve, schedule, or narrative submitted to District by Contractor under this Contract, nor District's review or acceptance of any such report, curve, schedule or narrative shall have the effect of amending or modifying in any way the Completion Date or milestone dates or of modifying or limiting in any way Contractor's obligations under this Contract.

#### **1.10 SCHEDULE REVISIONS**

- A. Updating the Schedule to reflect actual progress shall not be considered revisions to the Schedule. Since scheduling is a dynamic process, revisions to activity durations and sequences are expected on a monthly basis.
- B. To reflect revisions to the Schedule, the Contractor shall provide District with a written narrative with a full description and reasons for each Work activity revised. For revisions affecting the sequence of work, the Contractor shall provide a schedule diagram which compares the original sequence to the revised sequence of work. The Contractor shall provide the written narrative and schedule diagram for revisions two (2) working days in advance of the monthly schedule update meeting.
- C. Schedule revisions shall not be incorporated into any schedule update until the revisions have been reviewed by District. District may request further information and justification for schedule revisions and Contractor shall, within three (3) days, provide District with a complete written narrative response to District's request.
- D. If the Contractor's revision is still not accepted by District, and the Contractor disagrees with District's position, the Contractor has seven (7) calendar days from receipt of District's letter rejecting the revision to provide a written narrative providing full justification and explanation for the revision. The Contractor's failure to respond in writing within seven (7) calendar days of District's written rejection of a schedule revision shall be contractually interpreted as acceptance of District's position, and the Contractor waives its rights to subsequently dispute or file a claim regarding District's position.
- E. At District's discretion, the Contractor can be required to provide Subcontractor certifications of performance regarding proposed schedule revisions affecting said Subcontractors.

## **1.11 RECOVERY SCHEDULE**

- A. If the Schedule Update shows a completion date twenty-one (21) calendar days beyond the Contract Completion Date, or individual milestone completion dates, the Contractor shall submit to District the proposed revisions to recover the lost time within seven (7) calendar days. As part of this submittal, the Contractor shall provide a written narrative for each revision made to recapture the lost time. If the revisions include sequence changes, the Contractor shall provide a schedule diagram comparing the original sequence to the revised sequence of work.
- B. The Recovery Schedule shall include all revised work schedules and manpower projections required to recover the delay. If it is required to work weekends the Contractor shall inform the District and request support from the District/PMO. The Contractor will be required to pay for all costs associated with the recovery work.
- C. The revisions shall not be incorporated into any schedule update until the revisions have been reviewed by District.
- D. If the Contractor's revisions are not accepted by District, District and the Contractor shall follow the procedures in paragraph 1.09.C, 1.09.D and 1.09.E above.
- E. At District's discretion, the Contractor can be required to provide Subcontractor certifications for revisions affecting said Subcontractors.
- F. Under no circumstances will the addition of equipment or construction forces, increasing the working hours or any other method, manner, or procedure to return to the contractually required completion date be considered justification for a Contract Amendment or be treated as acceleration where the need for a recovery schedule has been caused by the Contractor and/or its Subcontractors, including its Suppliers/Vendors, at any tier.

## **1.12 TIME IMPACT EVALUATION ("TIE") FOR CHANGE ORDERS, AND OTHER DELAYS**

- A. When Contractor is directed to proceed with changed Work, the Contractor shall prepare and submit within fourteen (14) calendar days from the Notice to Proceed a TIE which includes both a written narrative and a schedule diagram depicting how the changed Work affects other schedule activities. The schedule diagram shall show how the Contractor proposes to incorporate the changed Work in the schedule and how it impacts the current schedule-update critical path. The Contractor is also responsible for requesting time extensions based on the TIE's impact on the critical path. The diagram must be tied to the main sequence of schedule activities to



enable District to evaluate the impact of changed Work to the scheduled critical path.

- B. Contractor shall be required to comply with the requirements of Paragraph 1.09.A for all types of delays such as, but not limited to, Contractor/Subcontractor delays, adverse weather delays, strikes, procurement delays, fabrication delays, etc.
- C. Contractor shall be responsible for all costs associated with the preparation of TIEs, and the process of incorporating them into the current schedule update. The Contractor shall provide District with one hard copy in addition to the electronic submittal of each TIE.
- D. Once agreement has been reached on a TIE, the Contract Time will be adjusted accordingly. If agreement is not reached on a TIE, the Contract Time may be extended in an amount District allows, and the Contractor may submit a claim for additional time claimed by contractor.

### **1.13 TIME EXTENSIONS**

- A. The Contractor is responsible for requesting time extensions for time impacts that, in the opinion of the Contractor, impact the critical path of the current schedule update. Notice of time impacts shall be given in accord with the General Conditions.
- B. Where an event for which District is responsible impacts the projected Completion Date, the Contractor shall provide a written mitigation plan, including a schedule diagram, which explains how (e.g., increase crew size, overtime, etc.) the impact can be mitigated. The Contractor shall also include a detailed cost breakdown of the labor, equipment, and material the Contractor would expend to mitigate District-caused time impact. The Contractor shall submit its mitigation plan to District within fourteen (14) calendar days from the date of discovery of the impact. The Contractor is responsible for the cost to prepare the mitigation plan.
- C. Failure to request time, provide TIE, or provide the required mitigation plan will result in Contractor waiving its right to a time extension and cost to mitigate the delay.
- D. No time will be granted under this Contract for cumulative effect of changes.
- E. District will not be obligated to consider any time extension request unless the Contractor complies with the requirements of Contract Documents.
- F. Failure of the Contractor to perform in accordance with the current schedule update shall not be excused by submittal of time extension requests.



- G. If the Contractor does not submit a TIE within the required fourteen (14) calendar days for any issue, it is mutually agreed that the Contractor does not require a time extension for said issue.

#### **1.14 SCHEDULE REPORTS**

- A. Submit one hard copy in addition to electronic submittal of the following reports with the Initial CPM Schedule, the Original CPM Schedule, and each monthly update.
- B. Required Reports:
  - (1) Two activity listing reports: one sorted by activity number and one by total Project Float. These reports shall also include each activity's early/late and actual start and finish dates, original and remaining duration, Project Float, responsibility code, and the logic relationship of activities.
  - (2) Schedule plots presenting time-scaled network diagram showing activities and their relationships with the controlling operations or critical path clearly highlighted.
  - (3) Cash flow report calculated by early start, late start, and indicating actual progress. Provide an exhibit depicting this information in graphic form.
  - (4) Planned versus actual resource (i.e., labor) histogram calculated by early start and late start.
- C. Other Reports:

In addition to above reports, District may request, from month to month, any two of the following reports. Submit four (4) copies of all reports.

  - (1) Activities by early start.
  - (2) Activities by late start.
  - (3) Activities grouped by Subcontractors or selected trades.
  - (4) Activities with scheduled early start dates in a given time frame, such as fifteen (15) or thirty (30) day outlook.
- D. Furnish District with report files on compact disks containing all schedule files for each report generated.

## 1.15 PROJECT STATUS REPORTING

- A. In addition to submittal requirements for CPM scheduling identified in this Section, Contractor shall provide a monthly project status report (i.e., written narrative report) to be submitted in conjunction with each CPM Schedule as specified herein. Status reporting shall be in form specified below.
- B. Contractor shall prepare monthly written narrative reports of status of Project for submission to District. Written status reports shall include:
  - (1) Status of major Project components (percent (%) complete, amount of time ahead or behind schedule) and an explanation of how Project will be brought back on schedule if delays have occurred.
  - (2) Progress made on critical activities indicated on CPM Schedule.
  - (3) Explanations for any lack of work on critical path activities planned to be performed during last month.
  - (4) Explanations for any schedule changes, including changes to logic or to activity durations.
  - (5) List of critical activities scheduled to be performed next month.
  - (6) Status of major material and equipment procurement.
  - (7) Any delays encountered during reporting period.
  - (8) Contractor shall provide printed report indicating actual versus planned resource loading for each trade and each activity. This report shall be provided on weekly and monthly basis.
    - (a) Actual resource shall be accumulated in field by Contractor, and shall be as noted on Contractor's daily reports. These reports will be basis for information provided in computer-generated monthly and weekly printed reports.
    - (b) Contractor shall explain all variances and mitigation measures.
  - (9) Contractor may include any other information pertinent to status of Project. Contractor shall include additional status information requested by District at no additional cost.
  - (10) Status reports, and the information contained therein, shall not be construed as claims, notice of claims, notice of delay, or requests for changes or compensation.

### **1.16 WEEKLY SCHEDULE REPORT**

At the Weekly Progress Meeting, the Contractor shall provide and present a time-scaled three (3) week look-ahead schedule that is based and correlated by activity number to the current schedule (i.e., Initial, Original CPM, or Schedule Update).

### **1.17 DAILY CONSTRUCTION REPORTS**

On a daily basis, Contractor shall submit a daily activity report to District for each workday, including weekends and holidays when worked. Contractor shall develop the daily construction reports on a computer-generated database capable of sorting daily Work, manpower, and man-hours by Contractor, Subcontractor, area, sub-area, and Change Order Work. Upon request of District, furnish computer disk of this data base. Obtain District's written approval of daily construction report data base format prior to implementation. Include in report:

- A. Project name and Project number.
- B. Contractor's name and address.
- C. Weather, temperature, and any unusual site conditions.
- D. Brief description and location of the day's scheduled activities and any special problems and accidents, including Work of Subcontractors. Descriptions shall be referenced to CPM scheduled activities.
- E. Worker quantities for its own Work force and for Subcontractors of any tier.
- F. Equipment, other than hand tools, utilized by Contractor and Subcontractors.

### **1.18 PERIODIC VERIFIED REPORTS**

Contractor shall complete and verify construction reports on a form prescribed by the Division of the State Architect and file reports on the first day of February, May, August, and November during the preceding quarter year; at the completion of the Contract; at the completion of the Work; at the suspension of Work for a period of more than one (1) month; whenever the services of Contractor or any of Contractor's Subcontractors are terminated for any reason; and at any time a special verified report is required by the Division of the State Architect. Refer to section 4-336 and section 4-343 of Part 1, Title 24 of the California Code of Regulations.

**PART 2 – PRODUCTS** Not Used.

**PART 3 - EXECUTION** Not Used.

END OF DOCUMENT

DOCUMENT 01 33 00

**SUBMITTALS**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS AND PROVISIONS:**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. General Conditions, including, without limitation, Contractor's Submittals and Schedules, Drawings and Specifications;
- B. Special Conditions.

**1.02 SECTION INCLUDES:**

- A. Definitions:
  - (1) Shop Drawings and Product Data are as indicated in the General Conditions and include, but are not limited to, fabrication, erection, layout and setting drawings, formwork and falsework drawings, manufacturers' standard drawings, descriptive literature, catalogues, brochures, performance and test data, wiring and control diagrams. In addition, there are other drawings and descriptive data pertaining to materials, equipment, piping, duct and conduit systems, and methods of construction as may be required to show that the materials, equipment or systems and all positions conform to the requirement of the Contract Documents, including, without limitation, the Drawings.
  - (2) "Manufactured" applies to standard units usually mass-produced; "fabricated" means specifically assembled or made out of selected materials to meet design requirements. Shop Drawings shall establish the actual detail of manufactured or fabricated items, indicated proper relation to adjoining work and amplify design details of mechanical and electrical equipment in proper relation to physical spaces in the structure.
  - (3) Manufacturer's Instructions: Where any item of Work is required by the Contract Documents to be furnished, installed, or performed, at a minimum, in accordance with a specified product manufacturer's instructions, the Contractor shall procure and distribute copies of these to the District, the Architect, and all other concerned parties and shall furnish, install, or perform the work, at a minimum, in accordance with those instructions.

- B. Samples, Shop Drawings, Product Data, and other items as specified, in accordance with the following requirements:
- (1) Contractor shall submit all Shop Drawings, Product Data, and Samples to the District, the Architect, the Project Inspector, and the Construction Manager.
  - (2) Contractor shall comply with all time frames herein and in the General Conditions and, in any case, shall submit required information in sufficient time to permit proper consideration and action before ordering any materials or items represented by such Shop Drawings, Product Data, and/or Samples.
  - (3) Contractor shall comply with all time frames herein and in the General Conditions and, in any case, shall allow sufficient time so that no delay occurs due to required lead time in ordering or delivery of any item to the Site. Contractor shall be responsible for any delay in progress of Work due to its failure to observe these requirements.
  - (4) Time for completion of Work shall not be extended on account of Contractor's failure to promptly submit Shop Drawings, Product Data, and/or Samples.
  - (5) Reference numbers on Shop Drawings shall have Architectural and/or Engineering Contract Drawings reference numbers for details, sections, and "cuts" shown on Shop Drawings. These reference numbers shall be in addition to any numbering system that Contractor chooses to use or has adopted as standard.
  - (6) When the magnitude or complexity of submittal material prevents a complete review within the stated time frame, Contractor shall make this submittal in increments to avoid extended delays.
  - (7) Contractor shall certify on submittals for review that submittals conform to Contract requirements. In event of any variance, Contractor shall specifically state in transmittal and on Shop Drawings, portions vary and require approval of a substitute. Also certify that Contractor-furnished equipment can be installed in allocated space.
  - (8) Unless specified otherwise, sampling, preparation of samples, and tests shall be in accordance with the latest standard of the American Society for Testing and Materials.
  - (9) Upon demand by Architect or District, Contractor shall submit samples of materials and/or articles for tests or examinations and consideration before Contractor incorporates same in Work.

Contractor shall be solely responsible for delays due to sample(s) not being submitted in time to allow for tests. Acceptance or rejection will be expressed in writing. Work shall be equal to approved samples in every respect. Samples that are of value after testing will remain the property of Contractor.

C. Submittal Schedule:

- (1) Contractor shall prepare its proposed submittal schedule that is coordinated with the its proposed construction schedule and submit both to the District within ten (10) days after the date of the Notice to Proceed. Contractor's proposed schedules shall become the Project Construction Schedule and the Project Submittal Schedule after each is approved by the District.
- (2) Contractor is responsible for all lost time should the initial submittal be rejected, marked "revise and resubmit", etc.
- (3) All Submittals shall be forwarded to the District by the date indicated on the approved Submittal Schedule, unless an earlier date is necessary to maintain the Construction Schedule, in which case those Submittals shall be forwarded to the District so as not to delay the Construction Schedule.

**1.03 SHOP DRAWINGS:**

- A. Contractor shall submit one reproducible transparency and six (6) opaque reproductions. The District will review and return the reproducible copy and one (1) opaque reproduction to Contractor.
- B. Before commencing installation of any Work, the Contractor shall submit and receive approval of all drawings, descriptive data, and material list(s) as required to accomplish Work.
- C. Review of Shop Drawings is regarded as a service to assist Contractor and in all cases original Contract Documents shall take precedence as outlined under General Conditions.
- D. No claim for extra time or payment shall be based on work shown on Shop Drawings unless the claim is (1) noted on Contractor's transmittal letter accompanying Shop Drawings and (2) Contractor has complied with all applicable provisions of the General Conditions, including, without limitation, provisions regarding changes and payment, and all required written approvals.
- E. District shall not review Shop Drawings for quantities of materials or number of items supplied.

- F. District's and/or Architect's review of Shop Drawing will be general. District and/or Architect review does not relieve Contractor of responsibility for dimensions, accuracy, proper fitting, construction of Work, furnishing of materials, or Work required by Contract Documents and not indicated on Shop Drawings. The District's and/or Architect's review of Shop Drawings is not to be construed as approving departures from Contract Documents.
- G. Review of Shop Drawings and Schedules does not relieve Contractor from responsibility for any aspect of those Drawings or Schedules that is a violation of local, County, State, or Federal laws, rules, ordinances, or rules and regulations of commissions, boards, or other authorities or utilities having jurisdiction.
- H. Before submitting Shop Drawings for review, Contractor shall check Shop Drawings of its subcontractors for accuracy, and confirm that all Work contiguous with and having bearing on other work shown on Shop Drawings is accurately drawn and in conformance with Contract Documents.
- I. Submitted drawings and details must bear stamp of approval of Contractor:
  - (1) Stamp and signature shall clearly certify that Contractor has checked Shop Drawings for compliance with Drawings.
  - (2) If Contractor submits a Shop Drawing without an executed stamp of approval, or whenever it is evident (despite stamp) that Drawings have not been checked, the District and/or Architect will not consider them and will return them to the Contractor for revision and resubmission. In that event, it will be deemed that Contractor has not complied with this provision and Contractor shall bear risk of all delays to same extent as if it had not submitted any Shop Drawings or details.
- J. Submission of Shop Drawings (in either original submission or when resubmitted with correction) constitutes evidence that Contractor has checked all information thereon and that it accepts and is willing to perform Work as shown.
- K. Contractor shall pay for cost of any changes in construction due to improper checking and coordination. Contractor shall be responsible for all additional costs, including coordination. Contractor shall be responsible for costs incurred by itself, the District, the Architect, the Project Inspector, the Construction Manager, any other Subcontractor or contractor, etc., due to improperly checked and/or coordination of submittals.
- L. Shop Drawings must clearly delineate the following information:

- (1) Project name and address.
  - (2) Specification number and description.
  - (3) Architect's name and project number.
  - (4) Shop Drawing title, number, date, and scale.
  - (5) Names of Contractor, Subcontractor(s) and fabricator.
  - (6) Working and erection dimensions.
  - (7) Arrangements and sectional views.
  - (8) Necessary details, including complete information for making connections with other Work.
  - (9) Kinds of materials and finishes.
  - (10) Descriptive names of materials and equipment, classified item numbers, and locations at which materials or equipment are to be installed in the Work. Contractor shall use same reference identification(s) as shown on Contract Drawings.
- M. Contractor shall prepare composite drawings and installation layouts when required to solve tight field conditions.
- (1) Shop Drawings shall consist of dimensioned plans and elevations and must give complete information, particularly as to size and location of sleeves, inserts, attachments, openings, conduits, ducts, boxes, structural interferences, etc.
  - (2) Contractor shall coordinate these composite Shop Drawings and installation layouts in the field between itself and its Subcontractor(s) for proper relationship to the Work, the work of other trades, and the field conditions. The Contractor shall check and approve all submittal(s) before submitting them for final review.

#### **1.04 PRODUCT DATA OR NON REPRODUCIBLE SUBMITTALS:**

- A. Contractor shall submit manufacturer's printed literature in original form. Any fading type of reproduction will not be accepted. Contractor must submit a minimum of six (6) each, to the District. District shall return one (1) to the Contractor, who shall reproduce whatever additional copies it requires for distribution.
- B. Contractor shall submit six (6) copies of a complete list of all major items of mechanical, plumbing, and electrical equipment and materials in



accordance with the approved Submittal Schedule, except as required earlier to comply with the approved Construction Schedule. Other items specified are to be submitted prior to commencing Work. Contractor shall submit items of like kind at one time in a neat and orderly manner. Partial lists will not be acceptable.

- C. Submittals shall include manufacturer's specifications, physical dimensions, and ratings of all equipment. Contractor shall furnish performance curves for all pumps and fans. Where printed literature describes items in addition to that item being submitted, submitted item shall be clearly marked on sheet and superfluous information shall be crossed out. If highlighting is used, Contractor shall mark all copies.
- D. Equipment submittals shall be complete and include space requirements, weight, electrical and mechanical requirements, performance data, and supplemental information that may be requested.
- E. Imported Materials Certification must be submitted at least ten (10) days before material is delivered.

#### **1.05 SAMPLES:**

- A. Contractor shall submit for approval Samples as required and within the time frame in the Contract Documents. Materials such as concrete, mortar, etc., which require on-site testing will be obtained from Project Site.
- B. Contractor shall submit four (4) samples except where greater or lesser number is specifically required by Contract Documents including, without limitation, the Specifications.
  - (1) Samples must be of sufficient size and quality to clearly illustrate functional characteristics, with integrally related parts and attachment devices.
  - (2) Samples must show full range of texture, color, and pattern.
- C. Contractor shall make all Submittals, unless it has authorized Subcontractor(s) to submit and Contractor has notified the District in writing to this effect.
- D. Samples to be shipped prepaid or hand-delivered to the District.
- E. Contractor shall mark samples to show name of Project, name of Contractor submitting, Contract number and segment of Work where representative Sample will be used, all applicable Specifications Sections and documents, Contract Drawing Number and detail, and ASTM or FS reference, if applicable.

- F. Contractor shall not deliver any material to Site prior to receipt of District's and/or Architect's completed written review and approval. Contractor shall furnish materials equal in every respect to approved Samples and execute Work in conformance therewith.
- G. District's and/or Architect's review, acceptance, and/or approval of Sample(s) will not preclude rejections of any material upon discovery of defects in same prior to final acceptance of completed Work.
- H. After a material has been approved, no change in brand or make will be permitted.
- I. Contractor shall prepare its Submittal Schedule and submit Samples of materials requiring laboratory tests to specified laboratory for testing not less than ninety (90) days before such materials are required to be used in Work.
- J. Samples which are rejected must be resubmitted promptly after notification of rejection and be marked "Resubmitted Sample" in addition to other information required.
- K. Field Samples and Mock-Ups are to be removed by Contractor at District's direction:
  - (1) Size: As Specified.
  - (2) Furnish catalog numbers and similar data, as requested.

#### **1.06 REVIEW AND RESUBMISSION REQUIREMENTS:**

- A. The District will arrange for review of Sample(s), Shop Drawing(s), Product Data, and other submittal(s) by appropriate reviewer and return to Contractor as provided below within twenty-one (21) days after receipt or within twenty-one (21) days after receipt of all related information necessary for such review, whichever is later.
- B. One (1) copy of product or materials data will be returned to Contractor with the review status.
- C. Samples to be incorporated into the Work will be returned to Contractor, together with a written notice designating the Sample with the appropriate review status and indicating errors discovered on review, if any. Other Samples will not be returned, but the same notice will be given with respect thereto, and that notice shall be considered a return of the Sample.
- D. Contractor shall revise and resubmit any Sample(s), Shop Drawing(s), Product Data, and other submittal(s) as required by the reviewer. Such

resubmittals will be reviewed and returned in the same manner as original Sample(s), Shop Drawing(s), Product Data, and other submittal(s), within fourteen (14) days after receipt thereof or within fourteen (14) days after receipt of all related information necessary for such review. Such resubmittal shall not delay the Work.

- E. Contractor may proceed with any of the Work covered by Sample(s), Shop Drawing(s), Product Data, and other submittal(s) upon its return if designated as no exception taken, or revise as noted, provided the Contractor proceeds in accordance with the District and/or the Architect's notes and comments.
- F. Contractor shall not begin any of the work covered by a Sample(s), Shop Drawing(s), Product Data, and other submittal(s), designated as revise and resubmit or rejected, until a revision or correction thereof has been reviewed and returned to Contractor.
- G. Sample(s), Shop Drawing(s), Product Data, and other submittal(s) designated as revise and resubmit or rejected and requiring resubmittal, shall be revised or corrected and resubmitted to the District no later than fourteen (14) days or a shorter period as required to comply with the approved Construction Schedule, after its return to Contractor.
- H. Neither the review nor the lack of review of any Sample(s), Shop Drawing(s), Product Data, and other submittal(s) shall waive any of the requirements of the Contract Documents, or relieve Contractor of any obligation thereunder.
- I. District's and/or Architect's review of Shop Drawings does not relieve the Contractor of responsibility for any errors that may exist. Contractor is responsible for the dimensions and design of adequate connections and details and for satisfactory construction of all the Work.

**PART 2 – PRODUCTS Not Used.**

**PART 3 - EXECUTION Not Used.**

END OF DOCUMENT

DOCUMENT 01 41 00

**REGULATORY REQUIREMENTS**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS AND PROVISIONS:**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. General Conditions, including, without limitation, Obtaining of Permits, Licenses and Registrations and Work to Comply with All Applicable Laws and Regulations;
- B. Special Conditions; and
- C. Quality Control.

**1.02 DESCRIPTION:**

This section covers the general requirements for regulatory requirements pertaining to the Work and is supplementary to all other regulatory requirements mentioned or referenced elsewhere in the Contract Documents.

**1.03 REQUIREMENTS OF REGULATORY AGENCIES:**

- A. All statutes, ordinances, laws, rules, codes, regulations, standards, and the lawful orders of all public authorities having jurisdiction over the Work, are hereby incorporated into these Contract Documents as if repeated in full herein and are intended to be included in any reference to Code or Building Code, unless otherwise specified, including, without limitation, the references in the list below. Contractor shall make available at the Site copies of all the listed documents applicable to the Work as the District and/or Architect may request, including, without limitation, applicable portions of the California Code of Regulations ("CCR").
  - (1) California Building Standards Administrative Code, Part 1, Title 24, CCR.
  - (2) California Building Code (CBC), Part 2, Title 24, CCR; (International Building Code volumes 1-2 and California Amendments).
  - (3) California Electrical Code (CEC), Part 3, Title 24, CCR; (National Electrical Code and California Amendments).
  - (4) California Mechanical Code (CMC), Part 4, Title 24, CCR; (Uniform Mechanical Code and California Amendments).

- (5) California Plumbing Code (CPC), Part 5, Title 24, CCR; (Uniform Plumbing Code and California Amendments).
  - (6) California Fire Code (CFC), Part 9, Title 24, CCR; (International Fire Code and California Amendments).
  - (7) California Referenced Standards Code, Part 12, Title 24, CCR.
  - (8) State Fire Marshal Regulations, Public Safety, Title 19, CCR.
  - (9) Partial List of Applicable National Fire Protection Association (NFPA) Standards:
    - (a) NFPA 13 - Automatic Sprinkler System.
    - (b) NFPA 14 - Standpipes Systems.
    - (c) NFPA 17A - Wet Chemical System
    - (d) NFPA 24 - Private Fire Mains.
    - (e) (California Amended) NFPA 72 - National Fire Alarm Codes.
    - (f) NFPA 253 - Critical Radiant Flux of Floor Covering System.
    - (g) NFPA 2001 - Clean Agent Fire Extinguishing Systems.
  - (10) California Division of the State Architect interpretation of Regulations ("DSA IR"), including, without limitation:
    - (a) DSA IR A-6 — Construction Change Document Submittal and Approval Processes.
    - (b) DSA IR A-7 — Project Inspector Certification and Approval.
    - (c) DSA IR A-8 — Project Inspector and Assistant Inspector Duties and Performance.
    - (d) DSA IR A-12 — Assistant Inspector Approval.
  - (11) DSA Procedures ("DSA PR")
    - (a) DSA PR 13-01 – Construction Oversight Process
  - (12) DSA PR 13-02 – Project Certification Process
- B. This Project shall be governed by applicable regulations, including, without limitation, the State of California's Administrative Regulations for the Division of the State Architect-Structural Safety (DSA/SS), Chapter 4, Part

1, Title 24, CCR, and the most current version on the date the bids are opened and as it pertains to school construction including, without limitation:

- (1) Test and testing laboratory per Section 4-335. District shall pay for the testing laboratory.
- (2) Special inspections per Section 4-333(c).
- (3) Deferred Approvals per section 4-317(g).
- (4) Verified reports per Sections 4-336 & 4-343(c).
- (5) Duties of the Architect & Engineers shall be per Section 4-333(a) and 4-341.
- (6) Duties of the Contractor shall be per Section 4-343.
- (7) Duties of Project Inspector shall be per Section 4-334.
- (8) Addenda and Construction Change Documents per Section 4-338.

Contractor shall keep and make available all applicable parts of the most current version of Title 24 referred to in the plans and specifications at the Site during construction.

C. Items of deferred approval shall be clearly marked on the first sheet of the Architect's and/or Engineer's approved Drawings. All items later submitted for approval shall be per Title 24 requirements to the DSA.

- (1) Contractor shall submit the following to Architect for review and endorsement:
  - (a) Product information on proposed material/system supplier.
  - (b) Drawings, specifications, and calculations prepared, signed, and stamped by an architect or engineer licensed in the State of California for that portion of the Work.
  - (c) All other requirements as may be required by DSA.
- (2) Cost of preparing and submitting documentation per DSA Deferred Approval requirements including required modifications to Drawings and Specifications, whether or not indicated in the Contract Documents, shall be borne by Contractor.
- (3) Contractor shall not begin fabrication and installation of deferred approval items without first obtaining DSA approval of Drawings and Specifications.

- (4) Schedule of Work Subject to DSA Deferred Approval: Window wall systems exceeding 10 feet in span.

**PART 2 – PRODUCTS** Not Used.

**PART 3 – EXECUTION** Not Used.

END OF DOCUMENT

DOCUMENT 01 43 00

**MATERIALS AND EQUIPMENT**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS AND PROVISIONS**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. General Conditions, including, without limitation, Purchase of Materials and Equipment;
- B. Special Conditions;
- C. Imported Materials Certification.

**1.02 MATERIAL AND EQUIPMENT**

- A. Only items approved by the District and/or Architect shall be used.
- B. Contractor shall submit lists of products and other product information in accordance with the Contract Documents, including, without limitation, the provisions regarding the submittals.

**1.03 MATERIAL AND EQUIPMENT COLORS**

- A. The District and/or Architect will provide a schedule of colors.
- B. No individual color selections will be made until after approval of all pertinent materials and equipment and after receipt of appropriate samples in accordance with the Contract Documents, including, without limitation, the provisions regarding the submittals.
- C. Contractor shall request priority in writing for any item requiring advance ordering to maintain the approved Construction Schedule.

**1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Contractor shall deliver manufactured materials in original packages, containers, or bundles (with seals unbroken), bearing name or identification mark of manufacturer.
- B. Contractor shall deliver fabrications in as large assemblies as practicable; where specified as shop-primed or shop-finished, package or crate as required to preserve such priming or finish intact and free from abrasion.



- C. Contractor shall store materials in such a manner as necessary to properly protect them from damage. Materials or equipment damaged by handling, weather, dirt, or from any other cause will not be accepted.
- D. Materials are not acceptable that have been warehoused for long periods of time, stored or transported in improper environment, improperly packaged, inadequately labeled, poorly protected, excessively shipped, deviated from normal distribution pattern, or reassembled.
- E. Contractor shall store material so as to cause no obstructions of sidewalks, roadways, access to the Site or buildings, and underground services. Contractor shall protect material and equipment furnished under Contract.
- F. Contractor may store materials on Site with prior written approval by the District, all material shall remain under Contractor's control and Contractor shall remain liable for any damage to the materials. Should the Project Site not have storage area available, the Contractor shall provide for off-site storage at a bonded warehouse and with appropriate insurance coverage at no cost to District.
- G. When any room in Project is used as a shop or storeroom, the Contractor shall be responsible for any repairs, patching, or cleaning necessary due to that use. Location of storage space shall be subject to prior written approval by District.

## **PART 2 - PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Manufacturers listed in various sections of Contract Documents are names of those manufacturers that are believed to be capable of supplying one or more of items specified therein.
- B. The listing of a manufacturer does not imply that every product of that manufacturer is acceptable as meeting the requirements of the Contract Documents.

### **2.02 FACILITIES AND EQUIPMENT**

Contractor shall provide, install, maintain, and operate a complete and adequate facility for handling, the execution, disposal, and distribution of material and equipment as required for proper and timely performance of Work connected with Contract.

### **2.03 MATERIAL REFERENCE STANDARDS**

Where material is specified solely by reference to "standard specifications" and if requested by District, Contractor shall submit for review data on actual material proposed to be incorporated into Work of Contract listing name and address of

vendor, manufacturer, or producer, and trade or brand names of those materials, and data substantiating compliance with standard specifications.

## **PART 3 - EXECUTION**

### **3.01 WORKMANSHIP**

- A. Where not more specifically described in any other Contract Documents, workmanship shall conform to methods and operations of best standards and accepted practices of trade or trades involved and shall include items of fabrication, construction, or installation regularly furnished or required for completion (including finish and for successful operation, as intended).
- B. Work shall be executed by tradespersons skilled in their respective lines of Work. When completed, parts shall have been durably and substantially built and present a neat appearance.

### **3.02 COORDINATION**

- A. Contractor shall coordinate installation of Work so as to not interfere with installation of others. Adjustment or rework because of Contractor's failure to coordinate will be at no additional cost to District.
- B. Contractor shall examine in-place work for readiness, completeness, fitness to be concealed or to receive other work, and in compliance with Contract Documents. Concealing or covering Work constitutes acceptance of additional cost which will result should in-place Work be found unsuitable for receiving other Work or otherwise deviating from the requirements of the Contract Documents.

### **3.03 COMPLETENESS**

Contractor shall provide all portions of the Work, unless clearly stated otherwise, installed complete and operational with all elements, accessories, anchorages, utility connections, etc., in manner to assure well-balanced performance, in accordance with manufacturer's recommendations and by Contract Documents. For example, electric water coolers require water, electricity, and drain services; roof drains require drain system; sinks fit within countertop, etc. Terms such as "installed complete," "operable condition," "for use intended," "connected to all utilities," "terminate with proper cap," "adequately anchored," "patch and refinish," "to match similar," should be assumed to apply in all cases, except where completeness of functional or operable condition is specifically stated as not required.

### **3.04 APPROVED INSTALLER OR APPLICATOR**

Installation by a manufacturer's approved installer or applicator is an understood part of Specifications and only approved installer or applicator is to provide on-site Work where specified manufacturer has on-going program of approving (i.e. certifying, bonding, re-warranting) installers or applicators. Newly established

relationships between a manufacturer and an installer or applicator who does not have other approved applicator work in progress or completed is not approved for this Project.

### **3.05 MANUFACTURER'S RECOMMENDATIONS**

All installations shall be in accordance with manufacturer's published recommendations and specific written directions of manufacturer's representative. Should Contract Documents differ from recommendations of manufacturer or directions of his representative, Contractor shall analyze differences, make recommendations to the District and the Architect in writing, and shall not proceed until interpretation or clarification has been issued by the District and/or the Architect.

END OF DOCUMENT

DOCUMENT 01 45 00

**QUALITY CONTROL**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS AND PROVISIONS:**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. General Conditions, including, without limitation, Inspector, Inspections and Tests, Uncovering of Work and Non-conforming of Work and Correction of Work;
- B. Special Conditions.

**1.02 RELATED CODES:**

- A. The Work is governed by requirements of Title 24, California Code of Regulations ("CCR"), and the Contractor shall keep a copy of these available at the job Site for ready reference during construction.
- B. The Division of the State Architect ("DSA") shall be notified at or before the start of construction.

**1.03 OBSERVATION AND SUPERVISION:**

- A. The District and Architect or their appointed representatives will review the Work and the Contractor shall provide facilities and access to the Work at all times as required to facilitate this review. Administration by the Architect and any consulting Structural Engineer will be in accordance with applicable regulations, including, without limitation, CCR, Part 1, Title 24, Section 4-341.
- B. One or more Project Inspector(s) approved by DSA and employed by or in contract with the District, referred to hereinafter as the "Project Inspector", will observe the work in accordance with CCR, Part 1, Title 24, Sections 4-333(b) and 4-342:
  - (1) The Project Inspector and Special Inspector(s) shall have access to the Work wherever it is in preparation or progress for ascertaining that the Work is in accordance with the Contract Documents and all applicable code sections. The Contractor shall provide facilities and operation of equipment as needed, and access as required and shall provide assistance for sampling or measuring materials.

- (2) The Project Inspector will notify the District and Architect and call the attention of the Contractor to any observed failure of Work or material to conform to Contract Documents.
- (3) The Project Inspector shall observe and monitor all testing and inspection activities required.

The Contractor shall conform with all applicable laws as indicated in the Contract Documents, including, without limitation, to CCR, Part 1, Title 24, Section 4-343. The Contractor shall supervise and direct the Work and maintain a competent superintendent on the job who is authorized to act in all matters pertaining to the Work. The Contractor's superintendent shall also inspect all materials, as they arrive, for compliance with the Contract Documents. Contractor shall reject defective Work or materials immediately upon delivery or failure of the Work or material to comply with the Contract Documents. The Contractor shall submit verified reports as indicated in the Contract Documents, including, without limitation, the Specifications and as required by Part 1, Title 24, Section 4-336.

#### **1.04 TESTING AGENCIES:**

- A. Testing agencies and tests shall be in conformance with the General Documents and the requirements of Part 1, Title 24, Section 4- 335.
- B. Testing and inspection in connection with earthwork shall be under the direction of the District's consulting soils engineer, if any, referred to hereinafter as the "Soils Engineer."
- C. Testing and inspection of construction materials and workmanship shall be performed by a qualified laboratory, referred to hereinafter as the "Testing Laboratory." The Testing Laboratory shall be under direction of an engineer registered in the State of California, shall conform to requirements of ASTM E329, and shall be employed by or in contract with the District.

#### **1.05 TESTS AND INSPECTIONS:**

- A. The Contractor shall be responsible for notifying the District and Project Inspector of all required tests and inspections. Contractor shall notify the District and Project Inspector at least seventy-two hours (72) hours in advance of performing any Work requiring testing or inspection.
- B. The Contractor shall provide access to Work to be tested and furnish incidental labor, equipment, and facilities to facilitate all inspections and tests.
- C. The District will pay for first inspections and tests required by the "CCR", and other inspections or tests that the District and/or the Architect may direct to have made, including the following principal items:

- (1) Tests and observations for earthwork and paving.
  - (2) Tests for concrete mix designs, including tests of trial batches.
  - (3) Tests and inspections for structural steel work.
  - (4) Field tests for framing lumber moisture content.
  - (5) Additional tests directed by the District that establish that materials and installation comply with the Contract Documents.
  - (6) Tests and observations of welding and expansion anchors.
- D. The District may at its discretion, pay and then back charge the Contractor for:
- (1) Retests or reinspections, if required, and tests or inspections required due to Contractor error or lack of required identifications of material.
  - (2) Uncovering of work in accordance with Contract Documents.
  - (3) Testing done on weekends, holidays, and overtime will be chargeable to the Contractor for the overtime portion.
  - (4) Testing done off Site.
- E. Testing and inspection reports and certifications:
- (1) If initially received by Contractor, Contractor shall provide to each of the following a copy of the agency or laboratory report of each test or inspection or certification.
    - (a) The District;
    - (b) The Construction Manager, if any;
    - (c) The Architect;
    - (d) The Consulting Engineer, if any;
    - (e) Other engineers on the Project, as appropriate;
    - (f) The Project Inspector; and
    - (g) The Contractor.
  - (2) When the test or inspection is one required by the CCR, a copy of the report shall also be provided to the DSA.

## **PART 2 - PRODUCTS**

### **2.01 TYPE OF TESTS AND INSPECTIONS:**

A. Testing and inspection shall be in accordance with DSA Form 103 (or current version). Tests below are typical examples and not fully inclusive of all tests and special inspections that may be required.

B. Slump Test  
ASTM C 143

C. Concrete Tests

Testing agency shall test concrete used in the work per the following paragraphs:

(1) Compressive Strength:

- (a) Minimum number of tests required: One (1) set of three (3) cylinders for each 100 cubic yards (Sec. 2604(h) 01) of concrete or major fraction thereof, placed in one (1) day. See Title 24, Section 2605(g).
- (b) Two cylinders of each set shall be tested at twenty-eight (28) days. One (1) cylinder shall be held in reserve and tested only when directed by the Architect or District.
- (c) Concrete shall test the minimum ultimate compressive strength in twenty-eight (28) days, as specified on the structural drawings.
- (d) In the event that the twenty-eight (28) day test falls below the minimum specified strength, the effective concrete in place shall be tested by taking cores in accordance with UBC Standard No. 26-13 and tested as required for cylinders.
- (e) In the event that the test on core specimens falls below the minimum specified strength, the concrete will be deemed defective and shall be removed and replaced upon such direction of the Architect, and in a manner acceptable to the Division of the State Architect.

D. Reinforcing, Steel

E. Structural Steel Per Title 24 and as noted:

- (1) Material: Steel per Table in Title 24, Section 2712.

- (2) Qualification of Welders (UBC Std. 27-6).
- (3) Shop fabrication (Section 2712(d). Structural steel only).
- (4) Shop and field welding (Section 2712(e)).

**PART 3 - EXECUTION** Not Used.

END OF DOCUMENT



DOCUMENT 01 50 00

**TEMPORARY FACILITIES AND CONTROLS**

**PART 1 – GENERAL**

**1.01 RELATED DOCUMENTS AND PROVISIONS:**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. General Conditions;
- B. Special Conditions;
- C. Site Standards; and
- D. Construction Waste Management and Disposal.

**1.02 TEMPORARY UTILITIES:**

- A. Electric Power and Lighting:
  - (1) To the extent power is available in the building(s) or on the Site, Contractor may use the District's existing utilities for the utilities used by Contractor and all Subcontractors. Contractor shall be responsible for providing temporary facilities required to deliver that power service from its existing location in the building(s) or on the Site to point of intended use.
  - (2) Contractor shall verify characteristics of power available in building(s) or on the Site. Contractor shall take all actions required to make modifications where power of higher voltage or different phases of current are required. Contractor shall be fully responsible for providing that service and shall pay all costs required therefor.
  - (3) Contractor shall furnish, wire for, install, and maintain temporary electrical lights wherever it is necessary to provide illumination for the proper performance and/or observation of the Work: a minimum of 20 foot-candles for rough work and 50 foot-candles for finish work.
  - (4) Contractor shall be responsible for maintaining existing lighting levels in the project vicinity should temporary outages or service interruptions occur.
- B. Heat and Ventilation:

- (1) Contractor shall provide temporary heat to maintain environmental conditions to facilitate progress of the Work, to meet specified minimum conditions for the installation and curing of materials, and to protect materials and finishes from damage due to improper temperature and humidity conditions. Portable heaters shall be standard units complete with controls.
- (2) Contractor shall provide forced ventilation and dehumidification, as required, of enclosed areas for proper installation and curing of materials, to disperse humidity, and to prevent hazardous accumulations of dust, fumes, vapors, and gases.
- (3) Contractor shall pay the costs of installation, maintenance, operation, and removal of temporary heat and ventilation, including costs for fuel consumed, required for the performance of the Work.

C. Water:

- (1) Contractor shall coordinate and pay for installation or use of water meter in compliance with local water agency requirements. To the extent water is then available in the building(s) or on the Site, Contractor may use the District's existing utilities by making prearranged payments to the District for the utilities used by Contractor and all Subcontractors. Contractor shall be responsible for providing temporary facilities required to deliver such utility service from its existing location in the building(s) on the Site, or other location approved by the local water agency, to point of intended use.
- (2) Contractor shall use backflow preventers on water lines at point of connection to District's water supply. Backflow preventers shall comply with requirements of Uniform Plumbing Code.
- (3) Contractor shall make potable water available for human consumption.

D. Sanitary Facilities:

- (1) Contractor shall provide sanitary temporary facilities in no fewer numbers than required by law and such additional facilities as may be directed by the Inspector for the use of all workers. The facilities shall be maintained in a sanitary condition at all times and shall be left at the Site until removal is directed by the Inspector or Contractor completes all other work at the Site.
- (2) Use of toilet facilities in the Work under construction shall not be permitted except by consent of the Inspector and the District.

E. Telephone Service:

- (1) Contractor shall arrange with local telephone service company for telephone service as required for the performance of the Work. Contractor shall, at a minimum, provide in its field office one line for telephone and one line for fax machine.
- (2) Contractor shall pay the costs for telephone and fax lines installation, maintenance, service, and removal.

F. Fire Protection:

- (1) Contractor shall provide and maintain fire extinguishers and other equipment for fire protection. Such equipment shall be designated for use for fire protection only and shall comply with all requirements of the California Fire, State Fire Marshall and/or its designee.
- (2) Where on-site welding and burning of steel is unavoidable, Contractor shall provide protection for adjacent surfaces.

G. Trash Removal:

- (1) Contractor shall provide trash removal on a timely basis. Under no circumstance shall Contractor use District trash service.

H. Field Office:

- (1) If Contractor chooses to provide a field office, it shall be an acceptable construction trailer that is well-lit and ventilated. The construction trailer shall be equipped with shelves, desks, filing cabinet, chairs, and such other items of equipment needed. Trailer and equipment are the property of the Contractor and must be removed from the Site upon completion of the Work. Contractor may use the corridor adjacent to the construction area for an office area, if approved in writing by District.
- (2) Contractor shall provide any additional electric lighting and power required for the trailer. Contractor shall make adequate provisions for heating and cooling as required.

**1.03 CONSTRUCTION AIDS:**

A. Plant and Equipment:

- (1) Contractor shall furnish, operate, and maintain a complete plant for fabricating, handling, conveying, installing, and erecting materials and equipment; and for conveyances for transporting workers.

Include elevators, hoists, debris chutes, and other equipment, tools, and appliances necessary for performance of the Work.

- (2) Contractor shall maintain plant and equipment in safe and efficient operating condition. Damages due to defective plant and equipment, and uses made thereof, shall be repaired by Contractor at no expense to the District.

- B. None of the District's tools and equipment shall be used by Contractor for the performance of the Work.

#### **1.04 BARRIERS AND ENCLOSURES:**

- A. Contractor shall obtain the District's written permission for locations and types of temporary barriers and enclosures, including fire-rated materials proposed for use, prior to their installation.

- B. Contractor shall provide and maintain temporary enclosures to prevent public entry and to protect persons using other buildings and portions of the Site and/or Premises, the public, and workers. Contractor shall also protect the Work and existing facilities from the elements, and adjacent construction and improvements, persons, and trees and plants from damage and injury from demolition and construction operations.

- C. Contractor shall provide site access to existing facilities for persons using other buildings and portions of the Site, the public, and for deliveries and other services and activities.

- D. Tree and Plant Protection:

- (1) Contractor shall preserve and protect existing trees and plants on the Premises that are not designated or required to be removed, and those adjacent to the Premises.
- (2) Contractor shall provide barriers to a minimum height of 4'-0" around drip line of each tree and plant, around each group of trees and plants, as applicable, in the proximity of demolition and construction operations, or as denoted on the Plans.
- (3) Contractor shall not park trucks, store materials, perform Work or cross over landscaped areas. Contractor shall not dispose of paint thinners, water from cleaning, plastering or concrete operations, or other deleterious materials in landscaped areas, storm drain systems, or sewers. Plant materials damaged as a result of the performance of the Work shall, at the option of the District and at Contractor's expense, either be replaced with new plant materials equal in size to those damaged or by payment of an amount

representing the value of the damaged materials as determined by the District.

- (4) Contractor shall remove soil that has been contaminated during the performance of the Work by oil, solvents, and other materials which could be harmful to trees and plants, and replace with good soil, at Contractor's expense.
- (5) Excavation around Trees:
  - (a) Excavation within drip lines of trees shall be done only where absolutely necessary and with written permission from the District.
  - (b) Where trenching for utilities is required within drip lines, tunneling under and around roots shall be by hand digging and shall be approved by the District. Main lateral roots and taproots shall not be cut. All roots 2 inches in diameter and larger shall be tunneled under and heavily wrapped with wet burlap so as to prevent scarring or excessive drying. Smaller roots that interfere with installation of new work may be cut with prior approval by the District. Roots must first be cut with a Vermeer, or equivalent, root cutter prior to any trenching.
  - (c) Where excavation for new construction is required within drip line of trees, hand excavation shall be employed to minimize damage to root system. Roots shall be relocated in backfill areas wherever possible. If encountered immediately adjacent to location of new construction, roots shall be cut approximately 6 inches back from new construction.
  - (d) Approved excavations shall be carefully backfilled with the excavated materials approved for backfilling. Backfill shall conform to adjacent grades without dips, sunken areas, humps, or other surface irregularities. Do not use mechanical equipment to compact backfill. Tamp carefully using hand tools, refilling and tamping until Final Acceptance as necessary to offset settlement.
  - (e) Exposed roots shall not be allowed to dry out before permanent backfill is placed. Temporary earth cover shall be provided, or roots shall be wrapped with four layers of wet, untreated burlap and temporarily supported and protected from damage until permanently relocated and covered with backfill.

- (f) Accidentally broken roots should be sawed cleanly 3 inches behind ragged end.

#### **1.05 SECURITY:**

The Contractor shall be responsible for project security for materials, tools, equipment, supplies, and completed and partially completed Work.

#### **1.06 TEMPORARY CONTROLS:**

##### **A. Noise Control:**

- (1) Contractor acknowledges that adjacent facilities may remain in operation during all or a portion of the Work period, and it shall take all reasonable precautions to minimize noise as required by applicable laws and the Contract Documents.
- (2) Notice of proposed noisy operations, including without limitation, operation of pneumatic demolition tools, concrete saws, and other equipment, shall be submitted to the District a minimum of forty-eight (48) hours in advance of their performance.

##### **B. Noise and Vibration:**

- (1) Equipment and impact tools shall have intake and exhaust mufflers.
- (2) Contractor shall cooperate with District to minimize and/or cease the use of noisy and vibratory equipment if that equipment becomes objectionable by its longevity.

##### **C. Dust and Dirt:**

- (1) Contractor shall conduct demolition and construction operations to minimize the generation of dust and dirt, and prevent dust and dirt from interfering with the progress of the Work and from accumulating in the Work and adjacent areas including, without limitation, occupied facilities.
- (2) Contractor shall periodically water exterior demolition and construction areas to minimize the generation of dust and dirt.
- (3) Contractor shall ensure that all hauling equipment and trucks carrying loads of soil and debris shall have their loads sprayed with water or covered with tarpaulins, and as otherwise required by local and state ordinance.

- (4) Contractor shall prevent dust and dirt from accumulating on walks, roadways, parking areas, and planting, and from washing into sewer and storm drain lines.

D. Water:

Contractor shall not permit surface and subsurface water, and other liquids, to accumulate in or about the vicinity of the Premises. Should accumulation develop, Contractor shall control the water or other liquid, and suitably dispose of it by means of temporary pumps, piping, drainage lines, troughs, ditches, dams, or other methods.

E. Pollution:

- (1) No burning of refuse, debris, or other materials shall be permitted on or in the vicinity of the Premises.
- (2) Contractor shall comply with applicable regulatory requirements and anti-pollution ordinances during the conduct of the Work including, without limitation, demolition, construction, and disposal operations.

F. Lighting:

- (1) If portable lights are used after dark, all light must be located so as not to direct light into neighboring property.

**1.07 JOB SIGN(S):**

A. General:

- (1) Contractor shall provide and maintain a Project identification sign with the design, text, and colors designated by the District and/or the Design Professional; locate sign as approved by the District.
- (2) Signs other than the specified Project sign and or signs required by law, for safety, or for egress, shall not be permitted, unless otherwise approved in advance by the District.

B. Materials:

- (1) Structure and Framing: Structurally sound, new or used wood or metal; wood shall be nominal 3/4-inch exterior grade plywood.
- (2) Sign Surface: Minimum 3/4-inch exterior grade plywood.
- (3) Rough Hardware: Galvanized.

- (4) Paint: Exterior quality, of type and colors selected by the District and/or the Design Professional.

C. Fabrication:

- (1) Contractor shall fabricate to provide smooth, even surface for painting.
- (2) Size: 4'-0" x 8'-0", unless otherwise indicated.
- (3) Contractor shall paint exposed surfaces of supports, framing, and surface material with exterior grade paint: one coat of primer and one coat of finish paint.
- (4) Text and Graphics: As indicated.

**1.08 PUBLICITY RELEASES:**

- A. Contractor shall not release any information, story, photograph, plan, or drawing relating information about the Project to anyone, including press and other public communications medium, including, without limitation, on website(s) without the written permission of the District.

**PART 2 – PRODUCTS** Not used.

**PART 3 – EXECUTION** Not used.

END OF DOCUMENT



## SECTION 01 66 00

### **PRODUCT DELIVERY, STORAGE AND HANDLING**

#### **PART 1 - GENERAL**

##### **1.01 RELATED DOCUMENTS AND PROVISIONS**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. General Conditions, including, without limitation, Site Access, Conditions and Requirements;
- B. Special Conditions.

##### **1.02 PRODUCTS**

- A. Products are as defined in the General Conditions.
- B. Contractor shall not use and/or reuse materials and/or equipment removed from existing Premises, except as specifically permitted by the Contract Documents.
- C. Contractor shall provide interchangeable components of the same manufacturer, for similar components.

##### **1.03 TRANSPORTATION AND HANDLING**

- A. Contractor shall transport and handle Products in accordance with manufacturer's instructions.
- B. Contractor shall promptly inspect shipments to confirm that Products comply with requirements, quantities are correct, and products are undamaged.
- C. Contractor shall provide equipment and personnel to handle Products by methods to prevent soiling, disfigurement, or damage.

##### **1.04 STORAGE AND PROTECTION**

- A. Contractor shall store and protect Products in accordance with manufacturer's instructions, with seals and labels intact and legible. Contractor shall store sensitive products in weather-tight, climate controlled enclosures.
- B. For exterior storage of fabricated Products, Contractor shall place on sloped supports, above ground.

- C. Contractor shall provide off-site storage and protection when Site does not permit on-site storage or protection.
- D. Contractor shall cover products subject to deterioration with impervious sheet covering and provide ventilation to avoid condensation.
- E. Contractor shall store loose granular materials on solid flat surfaces in a well-drained area and prevent mixing with foreign matter.
- F. Contractor shall provide equipment and personnel to store Products by methods to prevent soiling, disfigurement, or damage.
- G. Contractor shall arrange storage of Products to permit access for inspection and periodically inspect to assure Products are undamaged and are maintained under specified conditions.

**PART 2 – PRODUCTS** Not Used.

**PART 3 - EXECUTION** Not Used.

END OF DOCUMENT

DOCUMENT 01 71 23

**FIELD ENGINEERING**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS AND PROVISIONS:**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. General Conditions, including, without limitation, Site Investigation, and Soils Investigation Report;
- B. Special Conditions;
- C. Site-Visit Certification.

**1.02 REQUIREMENTS INCLUDED:**

- A. Contractor shall provide and pay for field engineering services by a California-registered engineer, required for the project, including, without limitations:
  - (1) Survey work required in execution of the Project.
  - (2) Civil or other professional engineering services specified, or required to execute Contractor's construction methods.

**1.03 QUALIFICATIONS OF SURVEYOR OR ENGINEERS:**

Contractor shall only use a qualified licensed engineer or registered land surveyor, to whom District makes no objection.

**1.04 SURVEY REFERENCE POINTS:**

- A. Existing basic horizontal and vertical control points for the Project are those designated on the Drawings.
- B. Contractor shall locate and protect control points prior to starting Site Work and preserve all permanent reference points during construction. In addition Contractor shall:
  - (1) Make no changes or relocation without prior written notice to District and Architect.

- (2) Report to District and Architect when any reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.
- (3) Require surveyor to replace Project control points based on original survey control that may be lost or destroyed.

#### **1.05 RECORDS:**

Contractor shall maintain a complete, accurate log of all control and survey work as it progresses.

#### **1.06 SUBMITTALS:**

- A. Contractor shall submit name and address of Surveyor and Professional Engineer to District and Architect prior to its/their work on the Project.
- B. On request of District and Architect, Contractor shall submit documentation to verify accuracy of field engineering work, at no additional cost to the District.
- C. Contractor shall submit a certificate signed by registered engineer or surveyor certifying that elevations and locations of improvements are in conformance or nonconformance with Contract Documents.

#### **PART 2 – PRODUCTS** Not Used.

#### **PART 3 - EXECUTION**

##### **3.01 COMPLIANCE WITH LAWS:**

Contractor is responsible for meeting all applicable codes, OSHA, safety and shoring requirements.

##### **3.02 NONCONFORMING WORK:**

Contractor is responsible for any re-surveying required by correction of nonconforming work.

END OF DOCUMENT

DOCUMENT 01 73 29

**CUTTING AND PATCHING**

**PART 1 – GENERAL**

**1.01 RELATED DOCUMENTS AND PROVISIONS:**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. General Conditions, including, without limitation, Inspector, Inspections, and Tests, Integration of Work, Nonconforming Work, and Correction of Work, and Uncovering Work;
- B. Special Conditions;
- C. Hazardous Materials Procedures and Requirements;
- D. Hazardous Materials Certification;
- E. Lead-Based Paint Certification;
- F. Imported Materials Certification.

**1.02 CUTTING AND PATCHING:**

- A. Contractor shall be responsible for all cutting, fitting, and patching, including associated excavation and backfill, required to complete the Work or to:
  - (1) Make several parts fit together properly.
  - (2) Uncover portions of Work to provide for installation of ill-timed Work.
  - (3) Remove and replace defective Work.
  - (4) Remove and replace Work not conforming to requirements of Contract Documents.
  - (5) Remove Samples of installed Work as specified for testing.
  - (6) Provide routine penetrations of non-structural surfaces for installation of piping and electrical conduit.
  - (7) Attaching new materials to existing remodeling areas – including painting (or other finishes) to match existing conditions.

- B. In addition to Contract requirements, upon written instructions from the District, Contractor shall uncover Work to provide for observations of covered Work in accordance with the Contract Documents; remove samples of installed materials for testing as directed by District; and remove Work to provide for alteration of existing Work.
- C. Contractor shall not cut or alter Work, or any part of it, in such a way that endangers or compromises the integrity of the Work, the Project, or work of others.

### **1.03 SUBMITTALS:**

- A. Prior to any cutting or alterations that may affect the structural safety of Project, or work of others, and well in advance of executing such cutting or alterations, Contractor shall submit written notice to District pursuant to the applicable notice provisions of the Contract Documents, requesting consent to proceed with the cutting or alteration, including the following:
  - (1) The work of the District or other trades.
  - (2) Structural value or integrity of any element of Project.
  - (3) Integrity or effectiveness of weather-exposed or weather-resistant elements or systems.
  - (4) Efficiency, operational life, maintenance or safety of operational elements.
  - (5) Visual qualities of sight-exposed elements.
- B. Contractor's Request shall also include:
  - (1) Identification of Project.
  - (2) Description of affected Work.
  - (3) Necessity for cutting, alteration, or excavations.
  - (4) Affects of Work on District, other trades, or structural or weatherproof integrity of Project.
  - (5) Description of proposed Work:
    - (a) Scope of cutting, patching, alteration, or excavation.
    - (b) Trades that will execute Work.
    - (c) Products proposed to be used.

- (d) Extent of refinishing to be done.
- (6) Alternates to cutting and patching.
- (7) Cost proposal, when applicable.
- (8) The scheduled date the Contractor intends to perform the Work and the duration of time to complete the Work.
- (9) Written permission of District or other District contractor(s) whose work will be affected.

#### **1.04 QUALITY ASSURANCE:**

- A. Contractor shall ensure that cutting, fitting, and patching shall achieve security, strength, weather protection, appearance for aesthetic match, efficiency, operational life, maintenance, safety of operational elements, and the continuity of existing fire ratings.
- B. Contractor shall ensure that cutting, fitting, and patching shall successfully duplicate undisturbed adjacent profiles, materials, textures, finishes, colors, and that materials shall match existing construction. Where there is dispute as to whether duplication is successful or has been achieved to a reasonable degree, the District's decision shall be final.

#### **1.05 PAYMENT FOR COSTS:**

- A. Cost caused by ill-timed or defective Work or Work not conforming to Contract Documents, including costs for additional services of the District, its consultants, including but not limited to the Construction Manager, the Architect, the Project Inspector(s), Engineers, and Agents, will be paid by Contractor and/or deducted from the Contract by the District.
- B. District shall only pay for cost of Work if it is part of the original Contract Price or if a change has been made to the contract in compliance with the provisions of the General Conditions. Cost of Work performed upon instructions from the District, other than defective or nonconforming Work, will be paid by District on approval of written Change Order. Contractor shall provide written cost proposals prior to proceeding with cutting and patching.

### **PART 2 - PRODUCTS**

#### **2.01 MATERIALS:**

- A. Contractor shall provide for replacement and restoration of Work removed. Contractor shall comply with the Contract Documents and with the Industry Standard(s), for the type of Work, and the Specification

requirements for each specific product involved. If not specified, Contractor shall first recommend a product of a manufacturer or appropriate trade association for approval by the District.

- B. Materials to be cut and patched include those damaged by the performance of the Work.

## **PART 3 – EXECUTION**

### **3.01 INSPECTION:**

- A. Contractor shall inspect existing conditions of the Site and the Work, including elements subject to movement or damage during cutting and patching, excavating and backfilling. After uncovering Work, Contractor shall inspect conditions affecting installation of new products.
- B. Contractor shall report unsatisfactory or questionable conditions in writing to District as indicated in the General Conditions and shall proceed with Work as indicated in the General Conditions by District.

### **3.02 PREPARATION:**

- A. Contractor shall provide shoring, bracing and supports as required to maintain structural integrity for all portions of the Project, including all requirements of the Project.
- B. Contractor shall provide devices and methods to protect other portions of Project from damage.
- C. Contractor shall, provide all necessary protection from weather and extremes of temperature and humidity for the Project, including without limitation, any work that may be exposed by cutting and patching Work. Contractor shall keep excavations free from water.

### **3.03 ERECTION, INSTALLATION AND APPLICATION:**

- A. With respect to performance, Contractor shall:
  - (1) Execute fitting and adjustment of products to provide finished installation to comply with and match specified tolerances and finishes.
  - (2) Execute cutting and demolition by methods that will prevent damage to other Work, and provide proper surfaces to receive installation of repairs and new Work.



- (3) Execute cutting, demolition excavating, and backfilling by methods that will prevent damage to other Work and damage from settlement.
- B. Contractor shall employ original installer or fabricator to perform cutting and patching for:
  - (1) Weather-exposed surfaces and moisture-resistant elements such as roofing, sheet metal, sealants, waterproofing, and other trades.
  - (2) Sight-exposed finished surfaces.
- C. Contractor shall execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances, and finishes as shown or specified in the Contract Documents including, without limitation, the Drawings and Specifications.
- D. Contractor shall fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces. Contractor shall conform to all Code requirements for penetrations or the Drawings and Specifications, whichever calls for a higher quality or more thorough requirement. Contractor shall maintain integrity of both rated and non-rated fire walls, ceilings, floors, etc.
- E. Contractor shall restore Work which has been cut or removed. Contractor shall install new products to provide completed Work in accordance with requirements of the Contract Documents and as required to match surrounding areas and surfaces.
- F. Contractor shall refinish all continuous surfaces to nearest intersection as necessary to match the existing finish to any new finish.

END OF DOCUMENT

DOCUMENT 01 76 00

**ALTERATION PROJECT PROCEDURES**

**PART 1 – GENERAL**

**1.01 RELATED DOCUMENTS AND PROVISIONS:**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. General Conditions, including, without limitation, Integration of Work, Purchase of Materials and Equipment, Uncovering of Work and Non-conforming Work and Correction of Work and Trenches;
- B. Special Conditions.

**PART 2 - PRODUCTS**

**2.01 PRODUCTS FOR PATCHING AND EXTENDING WORK:**

- A. New Materials: As specified in the Contract Documents including, without limitation, in the Specifications, Contractor shall match existing products, conditions, and work for patching and extending work.
- B. Type and Quality of Existing Products: Contractor shall determine by inspection, by testing products where necessary, by referring to existing conditions and to the Work as a standard.

**PART 3 - EXECUTION**

**3.01 EXAMINATION:**

- A. Contractor shall verify that demolition is complete and that areas are ready for installation of new Work.
- B. By beginning restoration Work, Contractor acknowledges and accepts the existing conditions.

**3.02 PREPARATION:**

- A. Contractor shall cut, move, or remove items as necessary for access to alterations and renovation Work. Contractor shall replace and restore these at completion.
- B. Contractor shall remove unsuitable material not as salvage unless otherwise indicated in the Contract Documents. Unsuitable material may include, without limitation, rotted wood, corroded metals, and deteriorated

masonry and concrete. Contractor shall replace materials as specified for finished Work.

- C. Contractor shall remove debris and abandoned items from all areas of the Site and from concealed spaces.
- D. Contractor shall prepare surface and remove surface finishes to provide for proper installation of new Work and finishes.
- E. Contractor shall close openings in exterior surfaces to protect existing work from weather and extremes of temperature and humidity. Contractor shall insulate ductwork and piping to prevent condensation in exposed areas. Contractor shall insulate building cavities for thermal and/or acoustical protection, as detailed.

### **3.03 INSTALLATION:**

- A. Contractor shall coordinate Work of all alternations and renovations to expedite completion and to accommodate District occupancy.
- B. Designated Areas and Finishes: Contractor shall complete all installations in all respects, including operational, mechanical work and electrical work.
- C. Contractor shall remove, cut, and patch Work in a manner to minimize damage and to provide a means of restoring Products and finishes to original or specified condition.
- D. Contractor shall refinish visible existing surfaces to remain in renovated rooms and spaces, to specified condition for each material, with a neat and square or straight transition to adjacent finishes.
- E. Contractor shall install products as specified in the Contract Documents, including without limitation, the Specifications.

### **3.04 TRANSITIONS:**

- A. Where new Work abuts or aligns with existing, Contractor shall perform a smooth and even transition. Patched Work must match existing adjacent work in texture and appearance.
- B. When finished surfaces are cut so that a smooth transition with new Work is not possible, Contractor shall terminate existing surface along a straight line at a natural line of division and make a recommendation for resolution to the District and the Architect for review and approval.

### **3.05 ADJUSTMENTS:**

- A. Where removal of partitions or walls results in adjacent spaces becoming one, Contractor shall rework floors, walls, and ceilings to a smooth plane without breaks, steps, or bulkheads.
- B. Where a change of plane of 1/4 inch or more occurs, Contractor shall submit a recommendation for providing a smooth transition to the District and the Architect for review and approval.
- C. Contractor shall trim and seal existing wood doors and shall trim and paint metal doors as necessary to clear new floor finish and refinish trim as required.
- D. Contractor shall fit Work at penetrations of surfaces.

### **3.06 REPAIR OF DAMAGED SURFACES:**

- A. Contractor shall patch or replace portions of existing surfaces, which are damaged, lifted, discolored, or showing other imperfections, in the area where the Work is performed.
- B. Contractor shall repair substrate prior to patching finish.

### **3.07 CULTIVATED AREAS AND OTHER SURFACE IMPROVEMENTS:**

- A. Cultivated or planted areas and other surface improvements which are damaged by actions of the Contractor shall be restored by Contractor to their original condition or better, where indicated.
- B. Contractor shall protect and replace, if damaged, all existing guard posts, barricades, and fences.
- C. Contractor shall give special attention to avoid damaging or killing trees, bushes and/or shrubs on the Premises and/or identified in the Contract Documents, including without limitation, the Drawings.

### **3.08 FINISHES:**

- A. Contractor shall finish surfaces as specified in the Contract Documents, including without limitations, the provisions of all Divisions of the Specifications.
- B. Contractor shall finish patches to produce uniform finish and texture over entire area. When finish cannot be matched, Contractor shall refinish entire surface to nearest intersections.

**3.09 CLEANING:**

- A. Contractor shall continually clean the Site and the Premises as indicated in the Contract Documents, including without limitation, the provisions in the General Conditions and the Specifications regarding cleaning.

END OF DOCUMENT

DOCUMENT 01 77 00

**CONTRACT CLOSEOUT AND FINAL CLEANING**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS AND PROVISIONS**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. General Conditions, including, without limitation, Completion of Work;
- B. Special Conditions;
- C. Temporary Facilities and Controls.

**1.02 CLOSEOUT PROCEDURES**

Contractor shall comply with all closeout provisions as indicated in the General Conditions.

**1.03 FINAL CLEANING**

- A. Contractor shall execute final cleaning prior to final inspection.
- B. Contractor shall clean interior and exterior glass and all surfaces exposed to view; remove temporary labels, tape, stains, and foreign substances, polish transparent and glossy surfaces, wax and polish new vinyl floor surfaces, vacuum carpeted and soft surfaces.
- C. Contractor shall clean equipment and fixtures to a sanitary condition.
- D. Contractor shall replace filters of operating equipment.
- E. Contractor shall clean debris from roofs, gutters, down spouts, and drainage systems.
- F. Contractor shall clean Site, sweep paved areas, and rake clean landscaped surfaces.
- G. Contractor shall remove waste and surplus materials, rubbish, and construction facilities from the Site and surrounding areas.

**1.04 ADJUSTING**

Contractor shall adjust operating products and equipment to ensure smooth and unhindered operation.

## **1.05 RECORD DOCUMENTS AND SHOP DRAWINGS**

- A. Contractor shall legibly mark each item to record actual construction, including:
  - (1) Measured depths of foundation in relation to finish floor datum.
  - (2) Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permit surface improvements.
  - (3) Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
  - (4) Field changes of dimension and detail.
  - (5) Details not on original Contract Drawings
  - (6) Changes made by modification(s).
  - (7) References to related Shop Drawings and modifications.
- B. Contractor will provide one set of Record Drawings to District.
- C. Contractor shall submit all required documents to District and/or Architect prior to or with its final Application for Payment.

## **1.06 INSTRUCTION OF DISTRICT PERSONNEL**

- A. Before final inspection, at agreed upon times, Contractor shall instruct District's designated personnel in operation, adjustment, and maintenance of products, equipment, and systems.
- B. For equipment requiring seasonal operation, Contractor shall perform instructions for other seasons within six months or by the change of season.
- C. Contractor shall use operation and maintenance manuals as basis for instruction. Contractor shall review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- D. Contractor shall prepare and insert additional data in Operation and Maintenance Manual when the need for such data becomes apparent during instruction.
- E. Contractor shall review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

#### **1.07 SPARE PARTS AND MAINTENANCE MATERIALS**

- A. Contractor shall provide products, spare parts, maintenance, and extra materials in quantities specified in the Specifications and in Manufacturer's recommendations.
- B. Contractor shall provide District with all required Operation and Maintenance Data at one time. Partial or piecemeal submissions of Operation and Maintenance Data will not be accepted.

**PART 2 – PRODUCTS** Not used.

**PART 3 – EXECUTION** Not used.

END OF DOCUMENT



DOCUMENT 01 78 23

**OPERATION AND MAINTENANCE DATA**

**PART 1 – GENERAL**

**1.01 RELATED DOCUMENTS AND PROVISIONS:**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. General Conditions, including, without limitation, Completion of the Work;
- B. Special Conditions.

**1.02 QUALITY ASSURANCE:**

Contractor shall prepare instructions and data by personnel experienced in maintenance and operation of described products.

**1.03 FORMAT:**

- A. Contractor shall prepare data in the form of an instructional manual entitled "OPERATIONS AND MAINTENANCE MANUAL & INSTRUCTIONS" ("Manual").
- B. Binders: Contractor shall use commercial quality, 8-1/2 by 11 inch, three-side rings, with durable plastic covers; two inch maximum ring size. When multiple binders are used, Contractor shall correlate data into related consistent groupings.
- C. Cover: Contractor shall identify each binder with typed or printed title "OPERATION AND MAINTENANCE MANUAL & INSTRUCTIONS"; and shall list title of Project and identify subject matter of contents.
- D. Contractor shall arrange content by systems process flow under section numbers and sequence of Table of Contents of the Contract Documents.
- E. Contractor shall provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- F. Text: The content shall include Manufacturer's printed data, or typewritten data on 24 pound paper.
- G. Drawings: Contractor shall provide with reinforced punched binder tab and shall bind in with text; folding larger drawings to size of text pages.

#### **1.04 CONTENTS, EACH VOLUME:**

- A. Table of Contents: Contractor shall provide title of Project; names, addresses, and telephone numbers of the Architect, any engineers, subconsultants, Subcontractor(s), and Contractor with name of responsible parties; and schedule of products and systems, indexed to content of the volume.
- B. For Each Product or System: Contractor shall list names, addresses, and telephone numbers of Subcontractor(s) and suppliers, including local source of supplies and replacement parts.
- C. Product Data: Contractor shall mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- D. Drawings: Contractor shall supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Contractor shall not use Project Record Documents as maintenance drawings.
- E. Text: The Contractor shall include any and all information as required to supplement product data. Contractor shall provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.
- F. Warranties and Bonds: Contractor shall bind in one copy of each.

#### **1.05 MANUAL FOR MATERIALS AND FINISHES:**

- A. Building Products, Applied Materials, and Finishes: Contractor shall include product data, with catalog number, size, composition, and color and texture designations. Contractor shall provide information for re-ordering custom manufactured products.
- B. Instructions for Care and Maintenance: Contractor shall include Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- C. Moisture Protection and Weather Exposed Products: Contractor shall include product data listing applicable reference standards, chemical composition, and details of installation. Contractor shall provide recommendations for inspections, maintenance, and repair.
- D. Additional Requirements: Contractor shall include all additional requirements as specified in the Specifications.

- E. Contractor shall provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

#### **1.06 MANUAL FOR EQUIPMENT AND SYSTEMS:**

- A. Each Item of Equipment and Each System: Contractor shall include description of unit or system, and component parts and identify function, normal operating characteristics, and limiting conditions. Contractor shall include performance curves, with engineering data and tests, and complete nomenclature, and commercial number of replaceable parts.
- B. Panelboard Circuit Directories: Contractor shall provide electrical service characteristics, controls, and communications.
- C. Contractor shall include color coded wiring diagrams as installed.
- D. Operating Procedures: Contractor shall include start-up, break-in, and routine normal operating instructions and sequences. Contractor shall include regulation, control, stopping, shut-down, and emergency instructions. Contractor shall include summer, winter, and any special operating instructions.
- E. Maintenance Requirements: Contractor shall include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- F. Contractor shall provide servicing and lubrication schedule, and list of lubricants required.
- G. Contractor shall include manufacturer's printed operation and maintenance instructions.
- H. Contractor shall include sequence of operation by controls manufacturer.
- I. Contractor shall provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- J. Contractor shall provide control diagrams by controls manufacturer as installed.
- K. Contractor shall provide Contractor's coordination drawings, with color coded piping diagrams as installed.
- L. Contractor shall provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

- M. Contractor shall provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- N. Additional Requirements: Contractor shall include all additional requirements as specified in Specification(s).
- O. Contractor shall provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

**1.07 SUBMITTAL:**

- A. Contractor shall submit to the District for review two (2) copies of preliminary draft or proposed formats and outlines of the contents of the Manual within thirty (30) days of Contractor's start of Work.
- B. For equipment, or component parts of equipment put into service during construction and to be operated by District, Contractor shall submit draft content for that portion of the Manual within ten (10) days after acceptance of that equipment or component.
- C. Contractor shall submit two (2) copies of a complete Manual in final form prior to final Application for Payment. Copy will be returned with Architect/Engineer comments. Contractor must revise the content of the Manual as required by District prior to District's approval of Contractor's final Application for Payment.
- D. Contractor must submit two (2) copies of revised Manual in final form within ten (10) days after final inspection.

**PART 2 – PRODUCTS** Not Used.

**PART 3 – EXECUTION** Not Used.

END OF DOCUMENT

DOCUMENT 01 78 36

**WARRANTIES**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS AND PROVISIONS**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. General Conditions, including, without limitation, Warranty/Guarantee Information;
- B. Special Conditions.

**1.02 FORMAT**

- A. Binders: Contractor shall use commercial quality, 8-1/2 by 11 inch, three-side rings, with durable plastic covers; two inch maximum ring size.
- B. Cover: Contractor shall identify each binder with typed or printed title "WARRANTIES" and shall list title of Project.
- C. Table of Contents: Contractor shall provide title of Project; name, address, and telephone number of Contractor and equipment supplier; and name of responsible principal. Contractor shall identify each item with the number and title of the specific Specification, document, provision, or section in which the name of the product or work item is specified.
- D. Contractor shall separate each warranty with index tab sheets keyed to the Table of Contents listing, providing full information and using separate typed sheets as necessary. Contractor shall list each applicable and/or responsible Subcontractor(s), supplier(s), and/or manufacturer(s), with name, address, and telephone number of each responsible principal(s).

**1.03 PREPARATION:**

- A. Contractor shall obtain warranties, executed in duplicate by each applicable and/or responsible subcontractor(s), supplier(s), and manufacturer(s), within ten (10) days after completion of the applicable item or work. Except for items put into use with District's permission, Contractor shall leave date of beginning of time of warranty blank until the date of completion is determined.
- B. Contractor shall verify that documents are in proper form, contain full information, and are notarized, when required.

- C. Contractor shall co-execute submittals when required.
- D. Contractor shall retain warranties until time specified for submittal.

**1.04 TIME OF SUBMITTALS:**

- A. For equipment or component parts of equipment put into service during construction with District's permission, Contractor shall submit a draft warranty for that equipment or component within ten (10) days after acceptance of that equipment or component.
- B. Contractor shall submit for District approval all warranties and related documents within ten (10) days after date of completion. Contractor must revise the warranties as required by the District prior to District's approval of Contractor's final Application for Payment.
- C. For items of work delayed beyond date of completion, Contractor shall provide an updated submittal within ten (10) days after acceptance, listing the date of acceptance as start of warranty period.

**PART 2 - PRODUCTS** Not Used.

**PART 3 – EXECUTION** Not Used.

### **GUARANTEE FORM**

\_\_\_\_\_ ("Contractor") hereby agrees that the \_\_\_\_\_  
\_\_\_\_\_ ("Work" of Contractor) which Contractor has installed for the MiraCosta  
Community College District ("District") for the following project:

PROJECT: \_\_\_\_\_

("Project" or "Contract") has been performed in accordance with the requirements of the  
Contract Documents and that the Work as installed will fulfill the requirements of the  
Contract Documents.

The undersigned agrees to repair or replace any or all of such Work that may prove to  
be defective in workmanship or material together with any other adjacent Work that may  
be displaced in connection with such replacement within a period of \_\_\_\_\_  
year(s) from the date of completion as defined in Public Contract Code section 7107,  
subdivision (c), ordinary wear and tear and unusual abuse or neglect excepted. The  
date of completion is \_\_\_\_\_, 20\_\_\_\_.

**Commented [A1]:** Minimum: one year;  
Optional: two years.

In the event of the undersigned's failure to comply with the above-mentioned conditions  
within a reasonable period of time, as determined by the District, but not later than  
seven (7) days after being notified in writing by the District, the undersigned authorizes  
the District to proceed to have said defects repaired and made good at the expense of  
the undersigned. The undersigned shall pay the costs and charges therefor upon  
demand.

Date: \_\_\_\_\_

Proper Name of Contractor: \_\_\_\_\_

Signature: \_\_\_\_\_

Print Name: \_\_\_\_\_

Title: \_\_\_\_\_

Representatives to be contacted for service subject to terms of Contract:

Name: \_\_\_\_\_

Address: \_\_\_\_\_

Phone No.: \_\_\_\_\_

Email: \_\_\_\_\_

END OF DOCUMENT

DOCUMENT 01 78 39

**RECORD DOCUMENTS**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS AND PROVISIONS:**

All Contract Documents should be reviewed for applicable provisions related to the provisions in this document, including without limitation:

- A. General Conditions, including, without limitation, Documents on Work;
- B. Special Conditions.

**PART 2 - RECORD DRAWINGS**

**2.01 GENERAL:**

- A. Contractor shall maintain at each Project Site one set of marked-up plans and shall transfer all changes and information to those marked-up plans, as often as required in the Contract Documents, but in no case less than once each month. Contractor shall submit to the Project Inspector one set of the Project Record Drawings ("As-Built") showing all changes incorporated into the Work since the preceding monthly submittal. The As-Built shall be available at the Project Site. The Contractor shall submit an electronic set and one (1) hard copy (or number as requested by the District) at the conclusion of the Project following review of the marked-up As-Built.
- B. Label and date each Record Drawing "RECORD DOCUMENT" in legibly printed letters.
- C. All deviations in construction, including but not limited to pipe and conduit locations and deviations caused by without limitation Change Orders, Construction Claim Directives, RFI's, and Addenda, shall be accurately and legibly recorded by Contractor.
- D. Locations and changes shall be done by Contractor in a neat and legible manner and, where applicable, indicated by drawing a "cloud" around the changed or additional information.

**2.02 RECORD DRAWING INFORMATION:**

- A. Contractor shall record the following information:



- (1) Locations of Work buried under or outside each building, including, without limitation, all utilities, plumbing and electrical lines, and conduits.
- (2) Actual numbering of each electrical circuit to match panel schedule.
- (3) Locations of significant Work concealed inside each building whose general locations are changed from those shown on the Contract Drawings.
- (4) Locations of all items, not necessarily concealed, which vary from the Contract Documents.
- (5) Installed location of all cathodic protection anodes.
- (6) Deviations from the sizes, locations, and other features of installations shown in the Contract Documents.
- (7) Locations of underground work, points of connection with existing utilities, changes in direction, valves, manholes, catch basins, capped stubouts, invert elevations, etc.
- (8) Sufficient information to locate Work concealed in each building with reasonable ease and accuracy.

In some instances, this information may be recorded by dimension. In other instances, it may be recorded in relation to the spaces in the building near which it was installed.

- B. Contractor shall provide additional drawings as necessary for clarification.
- C. Contractor shall provide reproducible record drawings, made from final Shop Drawings marked "No Exceptions Taken" or "Approved as Noted."
- D. After review and approval of the marked-up specifications by the Project Inspector, Contractor shall provide electronic copies of the drawings (in PDF format) with one file with all of the sheets and one set of individual sheet files at the conclusion of the Project.

## **PART 3 - RECORD SPECIFICATIONS**

### **3.01 GENERAL:**

- A. Contractor shall mark each section legibly to record manufacturer, trade name, catalog number, and supplier of each Product and item of equipment actually installed.

- B. After review and approval of the marked-up specifications by the Project Inspector, Contractor shall provide one electronic copy of the specifications (in PDF format) at the conclusion of the Project.

## **PART 4 - MAINTENANCE OF RECORD DOCUMENTS**

### **4.01 GENERAL**

- A. Contractor shall store Record Documents apart from documents used for construction as follows:
  - (1) Provide files and racks for storage of Record Documents.
  - (2) Maintain Record Documents in a clean, dry, legible condition and in good order.
- B. Contractor shall not use Record Documents for construction purposes.

## **PART 5 – PRODUCTS Not Used.**

END OF DOCUMENT

PBK Architects  
Project No. 20151

B900 Modernization  
MiraCosta Community College District, San Elijo Campus

## **SECTION 02 40 00 DEMOLITION – SITE WORK**

### **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. Description:
  - 1. Includes demolition of existing Site Developments, Landscape Infrastructure, Pavement, Service Facilities, and Site Infrastructure to accommodate proposed new construction and modernization work. Also includes supplementary clearing and grubbing requirements to face of existing structures schedule to remain.

### **PART 2 PRODUCTS (NOT USED)**

### **PART 3 EXECUTION**

#### **3.1 INFRASTRUCTURE REMOVAL**

- A. Existing infrastructure, developments, and site improvements scheduled for removal must be addressed in strict compliance with applicable laws and regulations.
- B. Contractor to secure authorized facility (ies) for disposal of generated rubble and demolition debris. Facility authorization must be submitted to the Owner and approved for use prior to beginning work.
- C. Dust and other airborne particles generated by site demolition activities must be controlled and reduced to acceptable air quality levels. Airborne particle retardant practices in strict accordance with erosion and pollution requirements are to be administered.
- D. Noise pollution is to be minimized during demolition activities. Excessive noise generating activities are to be scheduled between 0700 and 1700 hours, Monday through Friday to reduce the potential impact to adjacent property owners and occupants.

#### **3.2 PROTECTION**

- A. Locate, identify, and protect existing facilities (scheduled to remain) from damage.
- B. Identify and protect trees, plant growth, fences/gates and site features designated to remain. Coordinate this demolition work with that of Section 02 41 19: Selective Demolition.
- C. Identify and protect benchmarks from damage and displacement.

#### **3.3 CLEARING**

- A. Clear only those areas required for access to site and execution of Work as depicted in construction plans and described in scope of work.

#### **3.4 REMOVAL**

PBK Architects  
Project No. 20151

B900 Modernization  
MiraCosta Community College District, San Elijo Campus

- A. Remove paving, brush, trees, and other debris as required and dispose of off-site in strict accordance with applicable laws and regulations and only at facilities approved and authorized for such disposal.

**END OF SECTION 02 40 00**

PBK Architects  
Project No. 20151

B900 Modernization  
MiraCosta Community College District, San Elijo Campus

## **SECTION 02 41 19 SELECTIVE DEMOLITION**

### **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 requirements including but not limited to:
  - 1. Demolition and removal of selected portions of building or structure.
  - 2. Demolition and removal of selected portions of existing tile roofing.
  - 3. Demolition and removal of selected site elements.
  - 4. Accessories necessary for demolition and deconstruction.

#### **1.3 DEFINITIONS**

- A. Remove: Detach items from existing construction and dispose offsite.
- B. Remove and Reinstall: Detach items from existing construction with care to prevent damage, clean and refurbish, prepare for reuse, store as necessary, and reinstall where indicated.
- C. Deconstruct: To remove by disassembling or detaching an item from a surface, using methods and equipment to successfully prevent damage to the item and surfaces; and dispose of items.

#### **1.4 SUBMITTALS**

- A. Qualification Data: Submit copies of qualifications for refrigerant recovery technician.
- B. Engineering Survey: Submit engineering survey of condition of building, and roof structures.
- C. Proposed Protection Measures: Submit report, including Drawings, indicating proposed measures for protecting individuals and property, for environmental protection, dust control and noise control. Indicate proposed locations, types, and construction of barriers.
- D. Schedule of Selective Demolition Activities:
  - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on site operations are uninterrupted.
  - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
  - 3. Coordination for shutoff, capping, and continuation of utility services.
  - 4. Use of elevator and stairs.
  - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- E. Inventory: Submit a list of items for removal and location of storage of existing items to be removed saved and replaced (Tile Roofing)
- F. Pre-demolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces that could be construed as damage caused by demolition operations. Submit prior to commencement of the work.

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- G. Statement of Refrigerant Recovery: Submit statement signed by refrigerant recovery technician responsible for recovering refrigerant, stating that refrigerant present was recovered and recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- H. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

## **1.5 QUALITY ASSURANCE**

- A. Regulatory Requirements:
  - 1. Demolition Standards: Comply with ASSE A10.6 and NFPA 241.
  - 2. Comply with EPA regulations prior to commencement of the work. Comply with hauling and disposal regulations of authorities having jurisdiction.
  - 3. Comply with applicable federal, state, and local codes for demolition work, dust and noise control, safety of structure, and debris removal.
  - 4. Obtain required permits from authorities having jurisdiction.
- B. Refrigerant Recovery Technician Qualifications: Certified by an EPA approved certification program.
- C. Pre-demolition conference to be conducted at the site:
  - 1. Inspect and discuss condition of construction to be selectively demolished.
  - 2. Review structural load limitations of existing structure.
  - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
  - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
  - 5. Review areas where existing construction scheduled to remain and requires protection.
  - 6. Review with Owner Staging areas for equipment and material storage and removal.
- D. Arrange selective demolition schedule to avoid interference with Owner's and the school's operations.

## **1.6 WARRANTY**

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor prior to proceeding. Existing warranties to be provided by Owner prior to the start of construction.
- B. Notify warrantor on completion of selective demolition, and obtain documentation verifying existing system has been inspected and warranty remains in effect. Submit supporting documentation at closeout.

## **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and the contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

## **PART 2 PRODUCTS**

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## 2.1 MATERIALS

- A. Repair Materials:
  - 1. Use repair materials identical to existing materials:
    - a. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
    - b. Use materials whose installed performance equals or surpasses that of existing materials.
- B. Comply with material and installation requirements specified in individual Specification Sections.

## PART 3 EXECUTION

### 3.1 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted. Provide minimum of 72 hours' notice to Owner of demolition activities that will affect Owner's operations including but not limited to:
  - 1. Interruption of power.
  - 2. Interruption of utility services.
  - 3. Excessive noise.
- B. Condition of Structure:
  - 1. Conditions existing at time of inspection will be maintained by Owner as far as practical. Owner assumes no responsibility for actual condition of items or structures to be demolished:
    - a. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
    - b. Before commencing selective demolition, Owner will remove the following items:
      - 1) Classroom equipment (Tables, Chairs and District owned items).
- C. Hazardous Materials:
  - 1. It is not anticipated that hazardous materials will be encountered in the Work:
    - a. Hazardous materials will be removed by Owner before start of the Work.
    - b. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- D. Storage or sale of removed items or materials on site is not permitted.
- E. Traffic:
  - 1. Conduct operations and debris removal to ensure minimum interference with roads, streets, drives, fire lanes, walks, accessible paths, and adjacent occupied or used facilities:
    - a. Do not close, block, or obstruct streets, drives, walks, or occupied or used facilities without written permission from authorities having jurisdiction. Provide alternate routes around obstructed traffic ways.
- F. Explosives: Explosives are NOT permitted at the site.
- G. Flame Cutting: Do not use cutting torches for removal until flammable materials are removed. At concealed spaces, verify conditions prior to flame cutting operations. Maintain

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portable fire suppression devices during flame cutting operations.

- H. Environmental Controls: Use water sprinkling, temporary enclosures, or other acceptable methods to limit dust and dirt migration. Comply with governing regulations pertaining to environmental protection. Do not use water when it may create hazardous or objectionable conditions.
- I. Utility Services:
  - 1. Maintain existing utilities and protect against damage during demolition operations:
    - a. Do not interrupt utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, acceptable to Owner and governing authorities.
- J. Protections:
  - 1. Provide temporary barriers to protect Owner's personnel and public from injury from work:
    - a. Take protective measures to provide free and safe passage to occupied portions of building.
    - b. Provide protection to ensure safe passage of the Owner's personnel and the public around demolition areas and to and from occupied portions of adjacent areas, buildings, and structures.
    - c. Provide shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities or work to remain.
    - d. Protect existing work which becomes exposed during demolition operations:
      - 1) Protect existing improvements, appurtenances, and conditions to remain.
      - 2) Protect walls, openings, roofs, and adjacent exterior construction to remain and exposed to building demolition operations.
    - e. Provide temporary weather protection when exposing exterior conditions to prevent water leakage or damage to structure or interior areas of existing building.
- K. Damages: Promptly repair damages caused to adjacent facilities by demolition work.

### **3.2 EXAMINATION**

- A. Verify that affected utilities have been disconnected and capped before commencing selective demolition operations.
- B. Review Project Record Documents of existing construction or existing condition and hazardous material information provided by Owner. Owner does not warrant existing conditions are same as those indicated in Project Record Documents.
- C. Perform an engineering survey of condition of building to determine whether removing an element might result in structural deficiency or unplanned collapse of a portion of structure or adjacent structures during selective building demolition operations:
  - 1. Perform surveys as the work progresses to detect hazards resulting from selective demolition activities.
- D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- E. Survey of Existing Conditions:
  - 1. Record existing conditions with measured drawings or preconstruction photographs or video and templates:
    - a. Inventory and record the condition of items to be removed. Provide photographs or video of conditions that might be misconstrued as damage caused by operations.



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- b. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final work, make permanent record of measurements, materials, and construction details required to make exact reproduction.
- c. For any electrical or low-voltage work to be performed in the project (including fire alarm, PA, intercom, or data), test entire system for operation prior to initiation of work. Notify Owner of any non-working components. Test entire system at the end of construction to ensure all systems operate properly.

### 3.3 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.
- B. Pest Control: Employ certified, licensed exterminator to treat building and to control rodents and vermin before and during selective demolition operations.
- C. Site Access and Temporary Controls: Conduct selective demolition and debris removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities. Comply with requirements for access and protection.
- D. Temporary Facilities:
  - 1. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain:
    - a. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
    - b. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
    - c. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
    - d. Cover and protect furniture, furnishings, and equipment that have not been removed.
    - e. Comply with requirements for temporary enclosures, dust control, heating, and cooling.
- E. Furnishings and Equipment: Cover and protect furniture, equipment, and fixtures from spoilage or damage as necessary.
- F. Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise:
  - 1. Construct dustproof partitions of not less than nominal 4 inch (100mm) studs, 5/8 inch (16mm) gypsum wallboard with joints taped on occupied side, and 1/2 inch (13mm) fire retardant plywood on the demolition side.
  - 2. Insulate partition to provide noise protection to occupied areas.
  - 3. Seal joints and perimeter. Equip partitions with dustproof doors and security locks.
  - 4. Protect air handling equipment.
  - 5. Weatherstrip openings to prevent the spread of dust.

### 3.4 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving

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areas to be selectively demolished:

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Disconnect, demolish, and remove fire suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed:
  - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
  - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - e. Equipment to Be Removed: Disconnect and cap services and remove equipment and deliver to Owner.
  - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
  - g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

### 3.5 POLLUTION CONTROLS

- A. Dust Control:
  1. Use water mist, temporary enclosures, and suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations (North Coast Unified AQMD) including, but not limited to SCAQMD Rule 403 (Fugitive Dust):
    - a. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
    - b. Wet mop floors to eliminate trackable dirt and wipe down walls and doors of demolition enclosure. Vacuum carpeted areas.

### 3.6 PROTECTION

- A. Temporary Protection:
  1. Provide temporary barricades and protection required to prevent injury to people and damage to adjacent buildings and facilities to remain:
    - a. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building:
      - 1) Erect temporary pathways and means of egress necessary for ongoing operations compliant with Code and accessibility regulations.
      - 2) Provide temporary barricades and protection required to prevent injury and damage to adjacent buildings and facilities to remain.
    - b. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
    - c. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations:
      - 1) Protect existing work which becomes exposed during demolition operations.
      - 2) Protect adjacent entrances from damage due to demolition activities.
      - 3) Protect existing improvements, appurtenances, and conditions to remain.
      - 4) Protect floors with covering.
      - 5) Protect walls, openings, roofs, and adjacent exterior construction to remain

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- and exposed to building demolition operations.
  - 2. Cover and protect furniture, furnishings, and equipment that have not been removed.
  - 3. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 01 50 00:
    - a. Construct temporary insulated dustproof partitions to separate areas from noisy or extensive dirt or dust operations are performed. Equip partitions with dustproof doors and security locks.
    - b. Construct dustproof partitions of not less than nominal 4 inch (100mm) studs, 5/8 inch (16mm) gypsum wallboard with joints taped on occupied side, and 1/2 inch (13mm) fire retardant plywood on the demolition side.
    - c. Insulate partition to provide noise protection to occupied areas.
    - d. Seal joints and perimeter. Equip partitions with dustproof doors and security locks.
    - e. Protect air handling equipment.
    - f. Weatherstrip openings.
  - 4. Damage: Promptly repair damages to adjacent components cause by demolition activities.
- B. Temporary Shoring:
- 1. Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished:
    - a. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

### 3.7 SELECTIVE DEMOLITION

- A. Demolish and remove existing construction to the extent necessary for new work. Use methods required to complete the work within limitations of governing regulations and as follows:
- 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
  - 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
  - 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
  - 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame cutting operations. Maintain portable fire suppression devices during flame cutting operations.
  - 5. Maintain fire watch during and for at least 24 hours after flame cutting operations.
  - 6. Maintain adequate ventilation when using cutting torches.
  - 7. Remove decayed, vermin infested, and dangerous or unsuitable materials and promptly dispose of offsite.
  - 8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
  - 9. Locate selective demolition equipment and remove debris and materials to avoid imposing excessive loads on supporting walls, floors, or framing.
  - 10. Dispose of demolished items and materials promptly.
- B. Site Access and Temporary Controls: Conduct selective demolition and debris removal

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operations to ensure minimum interference with roads, streets, walks, walkways, and adjacent occupied and used facilities.

- C. Removed and Reinstalled Items:
  - 1. Clean and repair items to functional condition adequate for intended reuse:
    - a. Pack or crate items after cleaning and repairing. Identify contents of containers.
    - b. Protect items from damage during transport and storage.
    - c. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Owner, items may be removed to a suitable, protected storage location during selective demolition, cleaned, and reinstalled in original locations after selective demolition operations are complete.
- E. Patching and Repair: Repair damage to adjacent construction caused by selective demolition operations promptly.

### 3.8 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Remove to nearest control joint where possible. Using power driven saw, cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.
- B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.
- C. Concrete Slabs on Grade: Saw cut perimeter of area to be demolished, and then break up and remove.
- D. Interior Slab on Grade: Use best practice removal methods to prevent cracking or structurally disturbing adjacent slabs or partitions. Use power saw where possible.
- E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in *RFCI Recommended Work Practices for the Removal of Resilient Floor Coverings*. Do not use methods requiring solvent-based adhesive strippers.
- F. Below Grade Voids: Completely fill below grade areas and voids resulting from demolition work. Provide fill consisting of approved earth, gravel, or sand, free of trash and debris, stones over 6 (150mm) inches in diameter, roots, or other organic matter.
- G. Partitions: Completely remove indicated interior partitions and interior finishes indicated. Leave adjacent work scheduled to remain sound and ready for patching or for new finishes.
- H. Doors and Frames:
  - 1. Remove from site:
    - a. Remove doors, frames, and hardware where indicated.
- I. Windows: Remove existing windows where indicated. Remove associated anchors, shims, blocking, operating devices, sealant, and trim. Cut back interior finishes required for plumb surface for patching. Leave openings ready for installation of new materials and finishes.

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- J. Mechanical, Electrical, and Structural Elements:
  - 1. If unanticipated mechanical, electrical, or structural elements conflicting with intended function or design are encountered, investigate and measure both nature and extent of the conflict:
    - a. Submit written report to Architect in accurate detail. Pending receipt of directive, rearrange selective demolition schedule as necessary to continue overall job progress without undue delay.
    - b. HVAC Equipment: Remove air conditioning equipment without releasing refrigerants.

### 3.9 REMOVAL OF STRUCTURAL ELEMENTS

- A. Foundation: Demolish foundation walls to a minimum depth of 12 inches (300mm) below existing ground surface. Demolish and remove below grade wood or metal construction. Break up below grade concrete slabs.
- B. Pneumatic Operated Hammers:
  - 1. When possible, reduce use of pneumatic operated hammers. When necessary to use pneumatic tools, locate compressors as remote form occupied areas as possible:
    - a. To break large pieces of concrete, isolate concrete from floor slabs and building structure to prevent structure borne vibration.
- C. Saw Cutting:
  - 1. Locate compressors as remote as possible from occupied areas of facility:
    - a. Use diamond tipped saw blades and related equipment.
    - b. Saw cut portions of walls and slabs. Angle saw blade at floors and corners to cut as closely as possible to desired location.
    - c. Control runoff water used with saw to prevent damage to existing materials.

### 3.10 ROOF REMOVAL

- A. Roof Assembly:
  - 1. Remove existing roofing to the extent that can be covered in one day by new roofing. Maintain building interior in watertight and weathertight condition:
    - a. Remove existing roof membrane, flashings, copings, and roof accessories.
    - b. Remove existing clay tile roofing system down to plywood substrate. Salvage and store clay roof tile for re-installation.
- B. At new column extensions, cut through roofing as required for welding of new extension. Provide temporary watertight enclosure over stubs and temporarily flash to existing roof to make completely watertight.
- C. At existing parapets, remove portions of roofing, flashing, stone, and masonry necessary to weld new steel and set form work. Provide temporary watertight enclosures over areas of open roof and temporarily flash to make watertight.
- D. When removing roofing to place supports for shoring of form work to transfer loads to existing columns or approved structure or to support scaffolding, work platforms, or similar loads, temporarily flash supports to make roof watertight.
- E. Remove excess residue. Thoroughly clean and remove asphalt, dust, loose materials and leave ready for new work.

### 3.11 PATCHING AND REPAIRS

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- A. Promptly repair damage to adjacent construction caused by selective demolition operations.
- B. Patching: Comply with Section 01 73 29.
- C. Repairs:
  - 1. When necessary to repair to existing surfaces, patch to produce surfaces suitable for new materials:
    - a. Fill holes and depressions in existing masonry walls to remain with masonry patching material applied according to manufacturer's written recommendations.
- D. Finishes: Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.
- E. Floors and Walls:
  - 1. Where walls or partitions are demolished, extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance:
    - a. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
    - b. Where patching occurs in a painted surface, apply primer and intermediate paint coats over patch and apply final paint coat over entire unbroken surface containing patch. Provide additional coats until patch blends with adjacent surfaces.
    - c. Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
- F. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

### **3.12 DISPOSAL OF DEMOLISHED MATERIALS**

- A. Legally remove demolition waste materials from site and dispose in an EPA approved construction and demolition waste landfill acceptable to authorities having jurisdiction recycle or reuse components:
  - 1. Do not allow demolished materials to accumulate on site.
  - 2. Remove and transport debris to prevent spillage on adjacent surfaces and areas.
  - 3. Remove debris from elevated portions of building by chute, hoist, or devices that conveys debris to grade level in a controlled descent.
- B. Burning: Do not burn demolished materials.

### **3.13 CLEANING**

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

**END OF SECTION 02 41 19**

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## **SECTION 03 30 00 CAST-IN-PLACE CONCRETE**

### **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 specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
  - 1. Footings.
  - 2. Slabs-on-grade.
- B. Related Sections include the following:
  - 1. List below only products and construction that the reader might expect to find in this Section but are specified elsewhere.
  - 2. Division 31 Section "Earth Work" for drainage fill under slabs-on-grade.
  - 3. Division 32 Section "Concrete Paving" for concrete pavement and walks.

#### **1.3 DEFINITIONS**

- A. Definition in paragraph below refers to those materials that make up the cementitious component of the water-cementitious materials ratio.
- B. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.
- C. Cast-in-Place Architecturally Visible Concrete: Formed concrete that is viewed on surfaces of completed structure or building and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
  - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
  - 2. Indicate and provide documentation for each type of add mixture.
  - 3. Indicate water-cement ratio and strength for each mixture.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.



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## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer 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. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Testing Agency Qualifications: An independent agency, retained by the Owner and approved by the Division of State Architect, 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.
  - 2. Retain subparagraph below if requiring minimum qualifications for laboratory personnel performing testing and for laboratory supervisor.
  - 3. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
  - 1. ACI 301, "Specification for Structural Concrete,"
  - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- F. Pre-installation Conference: Conduct conference at Project site with Architect, Structural Engineer and Testing Agency to comply with requirements in Division 01 Section "Project Management and Coordination."
  - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
    - a. Contractor's superintendent.
    - b. Independent testing agency responsible for concrete design mixtures.
    - c. Ready-mix concrete manufacturer.
    - d. Concrete subcontractor.
  - 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semi-rigid joint fillers, forms and form removal limitations, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, concrete repair procedures, and concrete protection.
- G. Conformance shall be made with respect to respective requirements outlined in Sections 16A and 19A of CBC.
- H. Mockups: before casting architecturally visible concrete, build mockups to verify selections made under sample submittals and to demonstrate typical joints, surface finish, texture,



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tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the complete work:

1. Build mockups in the location and of the size indicated, if not indicated, as directed by Architect.
2. Build mockups of typical exterior wall of cast-in-place architectural concrete as shown on drawings to show reveals, pop outs, joints, form ties, and any other architectural features. Contractor to provide shop drawings of proposed mockup for approval prior to constructing mockups.
3. Demonstrate curing, cleaning, and protecting of cast-in-place architectural concrete, finishes, and contraction joints, as applicable.
4. In presence of Architect, damage part of the exposed-face surface for each finish, color, and texture and demonstrate materials and techniques proposed for repair of tie holes, and surface blemishes to match adjacent undamaged surfaces.
5. Obtain Architect's approval of mockups before casting concrete.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

## **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. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
  2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

### **2.2 FORM-FACING MATERIALS**

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
  1. Plywood, metal, or other approved panel materials.
  2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
    - a. Select one of four subparagraphs below or revise to suit Project. First imparts glossy finish, second imparts matte finish, and third and fourth impart coarser-textured finish depending on face-ply characteristics.
    - b. High-density overlay, Class 1 or better.
    - c. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
    - d. Structural 1, B-B or better; mill oiled and edge sealed.
    - e. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

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- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- E. Form-Release Agent: 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.
  - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- F. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
  - 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
  - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
  - 3. Furnish ties with integral water-barrier plates to walls indicated to receive damp-proofing or waterproofing.

## 2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed. Unless otherwise indicated on drawings.
- B. Reinforcing Bars at Shear Wall Boundaries and Bars to be Welded: A 706, Grade 60, deformed.
- C. Plain-Steel Wire: ASTM A 82, as indicated.
- D. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets, 60ksi minimum.

## 2.4 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
  - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
- C. Reinforcing Bar Couplers: Provide Type II where indicated on plans. For couplers to be used as alternate to lap splices, submit proposed coupler and proposed location for review and approval by EOR.

## 2.5 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, as noted below for the following conditions:
  - 1. Portland Cement at Architecturally Visible Concrete: ASTM C 150, Type III gray.
  - 2. Portland Cement at all other conditions: ASTM C 150, Type II/V.

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- a. Fly Ash: ASTM C 618, Class C or F, 100lbs. maximum per cubic yard, containing 1% or less carbon. Fly ash shall not be used in excess of 30% by weight of total cement quantity.
- B. Normal-Weight Aggregates: ASTM C 33, coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
  1. Select coarse-aggregate size from three options in subparagraph below; add gradation requirements if preferred. Aggregate size limits relate to spacing of steel reinforcement, depth of slab, or thickness of concrete member.
  2. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
  3. Retain subparagraph below if optional restriction for fine aggregate in ASTM C 33 is required.
  4. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Light-Weight Aggregates: ASTM C 330, expanded shale type coarse aggregate, dry loose weight maximum 38lbs. per cubic foot, maximum 9/16" size; all aggregate vacuum or thermally fully saturated for pump concrete.
- D. Water: ASTM C 94/C 94M and potable.

## 2.6 ADMIXTURES

- A. Chemical (Water Reducing) Admixture: ASTM C494, Type A, D, or E. Only one brand. When used, are subject to approval of University's Representative, and must reduce the mixing water at least 10% without entraining air in excess of 2% by volume. If the water reducing agent entrains more than 2% air, the water reduction shall be at least 12%, but in no case shall the water reducing agent entrain air in excess of 4%.
- B. Air-entraining admix: ASTM C260.
- C. Pozzolan: ASTM C618, Class F or C Fly Ash, 100 lbs. maximum per cubic yard, containing 1% or less carbon. Fly ash shall not be used in excess of 20% by weight of total cement quantity.
- D. Super-Plasticizers (High Range Water Reducers): ASTM C494, Type F or G. Master Builders "Rheobuild", Euclid "Eucon 37" or equal, capable of producing concrete which can be placed at 8-11" slump without segregation, capable of maintaining slump within 2" of that initially mixed for 2 hours, and of maintaining concrete temperature within 2° F. from time of batching for 2 hours minimum.

## 2.7 WATERSTOPS

- A. Flexible Rubber Waterstops: CE CRD-C 513 for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
  1. Manufacturers:
    - a. Greenstreak.
    - b. Progress Unlimited, Inc.
    - c. Williams Products, Inc.
    - d. Tremco Parastop II
    - e. Henry HF 302 Hydro-Flex Watertop
    - f. Cetco Waterstop-RX

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g. Or approved equal

## 2.8 VAPOR RETARDERS

- A. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.
- B. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 3/8-inch sieve, 10 to 30 percent passing a No. 100 sieve, and at least 5 percent passing No. 200 sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.
- C. Plastic Vapor Retarder: ASTM E 1745, Class B. Include manufacturer's recommended adhesive or pressure-sensitive tape.
  - 1. Stego Wrap; 10 mils. UNO on plans.

## 2.9 CURING MATERIALS

- A. Curing and Sealing Compound: Curing and sealing compound shall be VOC compliant, comply with ASTM C309, compatible with flooring adhesives.
  - 1. SpecChem E-Cure.
  - 2. Or approved equal.
- B. Select curing aids and materials from remaining paragraphs.
- C. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- D. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- E. Water: Potable.

## 2.10 RELATED MATERIALS

- A. Expansion and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Styrofoam: Expanded Polystyrene, Type X1, Density = 1pcf, Compressive strength 5psi @ 10% deformation.

## 2.11 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:
  - 1. Minimum Compressive Strength: 3,000 psi or as indicated on drawings at 28 days.
  - 2. Minimum Cementitious Materials Content: 540 lb/cu. yd.
  - 3. Slump Limit: 4 inches, plus or minus 1 inch.
  - 4. Maximum Water-Cementitious Materials Ratio: 0.45 for concrete surfaces to receive adhered flooring – 0.50 (elsewhere)

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## **PART 3 - EXECUTION**

### **3.1 FORMWORK**

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
  - 1. Refer to Architectural drawings for locations of finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
  - 1. Install keyways, reglets, recesses, and the like, for easy removal.
  - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete as directed by Architect.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
- M. Provide metal (smooth) formwork for Architecturally Visible Concrete to attain desired finish as directed in mockup.

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### 3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

### 3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50° F for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
  - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 75 percent of its 28-day design compressive strength.
  - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

### 3.4 VAPOR RETARDERS

- A. Granular Course: Cover vapor retarder with granular fill or fine-graded granular material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.

### 3.5 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
  - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

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### 3.6 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
  - 1. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
  - 2. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  - 3. Retain subparagraph above or below, or delete both if a bonding material is not permitted.
  - 4. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
  - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
  - 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 concrete develops random contraction cracks. Do not cut reinforcing.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
  - 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
  - 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants," are indicated.
  - 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate one-half of dowel length to prevent concrete bonding to one side of joint.

### 3.7 WATERSTOPS

- A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

### 3.8 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.



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- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
  - 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
  - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
  - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
  - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  - 2. Maintain reinforcement in position on chairs during concrete placement.
  - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
  - 4. Slope surfaces uniformly to drains where required.
  - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- E. 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 frost, freezing actions, or low temperatures.
  - 1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
  - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- F. Hot-Weather Placement: Comply with ACI 301 and as follows:
  - 1. During hot weather, proper attention shall be provided for ingredients, production methods, handling, placing, protection and curing, to prevent excessive concrete temperatures or water evaporation which could impair required strength or durability.
  - 2. Maintain concrete temperature below 90 deg F at time of placement. 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.
  - 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

### 3.9 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  - 1. Apply to concrete surfaces not exposed to public view.



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- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  - 1. Apply to concrete surfaces exposed to public view (Architecturally Visible Concrete).
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

### **3.10 FINISHING FLOORS AND SLABS**

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture
  - 1. Apply float finish to surfaces indicated on drawings.
- C. Broom Finish: Exterior stair treads and landings shall be provided with a non-slip broom finish in addition to abrasive finish specified.
- D. Abrasive Stair Nosing: Nosing shall be installed according to manufacturers written recommendations.

### **3.11 MISCELLANEOUS CONCRETE ITEMS**

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

### **3.12 CONCRETE PROTECTING AND CURING**

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

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- B. Evaporation Retarder: Apply evaporation retarder to unformed 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.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
  - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
  - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
    - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
  - 3. Curing 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. Maintain continuity of coating and repair damage during curing period.
    - a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.
  - 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a 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.

### 3.13 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions where indicated on drawings.
  - 1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semi-rigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

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### 3.14 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
  - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  - 2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
  - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
  - 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  - 2. After concrete has cured at least 14 days, correct high areas by grinding.
  - 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
  - 4. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
  - 5. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

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- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

### 3.15 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
1. Steel reinforcement placement.
  2. Headed bolts and studs.
  3. Verification of use of required design mixture.
  4. Concrete placement, including conveying and depositing.
  5. Curing procedures and maintenance of curing temperature.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
  2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
    - a. 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.
  3. 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 mixture. Perform additional tests when concrete consistency appears to change.
  4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
  5. Compression Test Specimens: ASTM C 31/C 31M.
    - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
    - b. Cast and field cure 2 sets of two standard cylinder specimens for each composite sample.
  6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
    - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
  7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
  8. Strength of each concrete mixture will be satisfactory if every average of any three 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.
  9. Test results shall be reported in writing to Architect, 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.

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10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
11. 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 Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

**END OF SECTION 03 30 00**

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## **SECTION 05 12 00 STRUCTURAL STEEL FRAMING**

### **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. Structural steel.
  - 2. Grout.
- B. Related Sections include the following:
  - 1. Division 01 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
  - 2. Division 05 Section "Steel Decking" for field installation of shear connectors.
  - 3. Division 05 Section "Metal Fabrications" for miscellaneous steel fabrications and other metal items not defined as structural steel.

#### **1.3 DEFINITIONS**

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B.
- C. Shop Drawings: Show fabrication of structural-steel components.
  - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
  - 2. Include embedment drawings.
  - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
  - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pre-tensioned and slip-critical high-strength bolted connections.
- D. Weld Procedures: Submit weld procedures for connections other than rigid frames. Weld procedures shall be qualified as described in AWS D1.5, Section 5.12 or 5.13 for self-shielded FCAW, Weld procedures shall indicate joints details and tolerances, preheat and interpass temperature, post-heat treatment, single or multiple stringer passes, peening of stringer passes for groove welds except for the first and the last pass, electrode type and size, welding current, polarity and amperes and root treatment. The welding variables for each stringer pass shall be recorded and averaged, from these averages the weld heat input shall be calculated.
- E. Welder's Certificates: Field welders shall be Project certified in accordance with AWS D1. 1-02. Shop welders shall be Project certified for FCAWS in accordance with AWS D1. 1-02.

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- F. Coordinate first paragraph below with qualification requirements in Division 01 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.
- G. Qualification Data: For Installer and fabricator.
- H. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
  - 1. Structural steel including chemical and physical properties.
  - 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
  - 3. Direct-tension indicators.
  - 4. Tension-control, high-strength bolt-nut-washer assemblies.
  - 5. Shear stud connectors.
  - 6. Shop primers.
  - 7. Non-shrink grout.
- I. Source quality-control test reports.
- J. Charpy-V-Notch (CVN) Impact Test: Submit certified copies of Charpy-V-Notch (CVN) Impact Test by the manufacturer for applicable steel members and components.
  - 1. Charpy-V-Notch (CVN) Impact Test for Base Metal: Moment frame columns, girders and other structural steel which is to be complete joint penetration welded and subjected to Charpy-V-Notch impact test in accordance with ASTM E 23 and ASTM A 673.
- K. Exception: Rolled shapes listed under Groups 4 and 5 of Table 2, Page 1-8 of the 9th edition of the AISC Manual of Steel Construction shall have the Charpy-V-Notch test, as specified above, performed on flange material at the juncture of the web and flange, shown in Figure C-A3 1C in AISC Manual – 9th edition.
  - 1. Charpy-V-Notch test shall be performed by the manufacturer employing Test Frequency (P) in accordance with ASTM A 673 and utilizing standard specimen sizes shown in Figure 6 of ASTM E 23. The absorbed energy in a CVN impact test shall not be less than that specified in Material Part 2 of this section.
  - 2. Sustainable Design Requirements submittal form, found in Appendix A of Section 0810 "Sustainable Design Requirements". Provide the following for all structural steel framing:
    - a. Recycled content
    - b. Regional materials (if applicable)

## 1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."
- B. Comply with applicable provisions of the following specifications and documents:
  - 1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
  - 2. AISC's "Seismic Provisions for Structural Steel Buildings" and "Supplement No. 2."
  - 3. AISC's "Load and Resistance Factor Design Specification for Structural Steel Buildings."
  - 4. AISC's "Specification for the Design of Steel Hollow Structural Sections."
  - 5. AISC's "Specification for Load and Resistance Factor Design of Single-Angle Members."
  - 6. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."



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- C. Delete below if Work of this Section is not extensive or complex enough to justify a preinstallation conference. If retaining, coordinate with Division 01.
- D. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
  - 1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
  - 2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

## **1.7 COORDINATION**

- A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

## **PART 2 - PRODUCTS**

### **2.1 STRUCTURAL-STEEL MATERIALS**

- A. W-Shapes: ASTM A 992, ASTM A 572, Grade 50.
- B. Channels, Angles, M, S-Shapes: ASTM A 36 Grade 36.
- C. Plate and Bar: ASTM A 36, Grade 36.
- D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing, 46 ksi.
- E. Steel Pipe: ASTM A 53, Type E or S, Grade B, 35 ksi.
  - 1. Finish: Primer and galvanized where indicated.
- F. Welding Electrodes: Comply with AWS requirements.

### **2.2 BOLTS, CONNECTORS, AND ANCHORS**

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers, plain.
  - 1. Finish: Plain.
  - 2. Direct-Tension Indicators: ASTM F 959, Type 325 compressible-washer type.
    - a. Finish: Plain.
- B. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers, plain.
  - 1. Direct-Tension Indicators: ASTM F 959, Type 490, compressible-washer type, plain.



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- C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy hex head steel structural bolts with splined ends; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
  - 1. Finish: Plain.
- D. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
- E. Headed Anchor Rods: ASTM A 307, Grade A, unless specified otherwise on drawings.
  - 1. Nuts: ASTM A 563 hex carbon steel.
  - 2. Plate Washers: ASTM A 36 carbon steel.
  - 3. Washers: ASTM F 436 hardened carbon steel.
  - 4. Finish: Plain.
- F. Threaded Rods: ASTM A 36.
  - 1. Nuts: ASTM A 563 hex carbon steel.
  - 2. Washers: ASTM F 436 hardened carbon steel.
  - 3. Finish: Plain.

## 2.3 PRIMER

- A. Primer: SSPC-Paint 25, Type II, iron oxide, zinc oxide, raw linseed oil, and alkyd.

## 2.4 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, non-metallic aggregate grout, non-corrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

## 2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Load and Resistance Factor Design Specification for Structural Steel Buildings."
  - 1. Camber structural-steel members where indicated.
  - 2. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
  - 3. Mark and match-mark materials for field assembly.
  - 4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
  - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.
- C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

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- F. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members. Delete option in first subparagraph below if allowing thermally cut holes.
  - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
  - 2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
  - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

## 2.6 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
  - 1. Joint Type: Snug tightened, pre-tensioned or slip critical as indicated.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
  - 1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

## 2.7 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
  - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
  - 2. Surfaces to be field welded.
  - 3. Surfaces to be high-strength bolted with slip-critical connections.
  - 4. Surfaces to receive sprayed fire-resistive materials.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
  - 1. SSPC-SP 2, "Hand Tool Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
  - 1. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

## 2.8 SOURCE QUALITY CONTROL

- A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
  - 1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

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- C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option: Select applicable nondestructive testing methods from four subparagraphs below. Revise to indicate extent of weld inspections if applicable and to add alternative acceptance criteria to AWS D1.1 if required.
  - 1. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
  - 2. Ultrasonic Inspection: ASTM E 164.
  - 3. Radiographic Inspection: ASTM E 94.
- E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:
  - 1. Bend tests will be performed if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.
  - 2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

## **PART 3- EXECUTION**

### **3.1 EXAMINATION**

- A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.
  - 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

### **3.3 ERECTION**

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Load and Resistance Factor Design Specification for Structural Steel Buildings."
- B. Base and Bearing Plates: Clean concrete bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
  - 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
  - 2. Weld plate washers to top of base plate.

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3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
  4. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
1. Level and plumb individual members of structure.
  2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- G. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

### 3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Load and Resistance Factor Design Specification for Structural Steel Buildings" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
- B. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.
1. In addition to visual inspection, field welds will be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:

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- a. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
  - b. Ultrasonic Inspection: ASTM E 164.
  - c. Radiographic Inspection: ASTM E 94.
- A. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1 for stud welding and as follows:
  - 1. Perform bend tests if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.
  - 2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

### **3.6 REPAIRS AND PROTECTION**

- A. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel. Applicable to galvanized connections.
  - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
  - 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.
- B. Touchup Painting: Cleaning and touchup painting are specified in Division 09 painting Sections.

**END OF SECTION 05 12 00**

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## **SECTION 05 50 00 METAL FABRICATIONS**

### **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 requirements including but not limited to:
  - 1. Steel framing and supports
  - 2. Shelf angles.
  - 3. Miscellaneous steel trim including steel angle corner guards, and steel edgings.
  - 4. Metal Finishes.
  - 5. Accessories necessary for a coordinated and complete installation.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Design countertop supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance of Roof Anchor Points. Provide anchor points suitable for support of 5,000lbs breaking point. (See Structural Drawings)
- C. Structural Performance:
  - 1. Countertops and Vanities:
    - a. Provide countertop and vanity framing capable of withstanding the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections, or of exhibiting excessive deflections in any of the components making up the countertops and vanities:
      - 1) All deadloads.
      - 2) 250 pound live load placed on the countertop and vanity.
      - 3) Deflection at Midspan: L/1000 times span or 1/8 inch whichever is less.
- D. Thermal Movements:
  - 1. Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss:
    - a. Temperature Change (Range): 70 degrees F, ambient; 110 degrees F, material surfaces.

#### **1.4 SUBMITTALS**

- A. Product Data: Submit data for miscellaneous metal fabrications and paint, coatings, and grout accessories.
- B. Shop Drawings:
  - 1. Submit shop drawings detailing the fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and

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their connections. Show anchorage and accessory items:

- b. For installed products indicated to comply with design loads, include structural analysis data, for information only, signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Welding certificates.
- E. Paint Compatibility Certificates: Submit manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

## 1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Building Code: Comply with applicable provisions of the CBC 2019 California Building Code (CCR Title 24, Part 2, as adopted and amended by DSA).
  - 2. Welding:
    - a. Qualify procedures and personnel according to the following:
      - 1) AWS D1.1/D1.1M Structural Welding Code - Steel.
      - 2) AWS D1.2/D1.2 M Structural Welding Code - Aluminum.
      - 3) AWS D1.6/D1.6M Structural Welding Code - Sheet Steel.
      - 4) Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Fabricator/Installer Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project for a minimum of 5 years, with a record of successful in service performance, with sufficient production capacity to produce required units without causing delay in the work.

## 1.6 STORAGE, DELIVERY, AND HANDLING

- A. Store metal fabrications in a dry, well ventilated, weathertight place. Deliver and handle so as to prevent any type of damage to the fabricated work.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Stainless Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.
- D. Stainless Steel Bars and Shapes: ASTM A 276, Type 304.
- E. Rolled Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- F. Rolled Stainless Steel Floor Plate: ASTM A 793.



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- G. Abrasive Surface Floor Plate:
  - 1. Steel plate with abrasive granules rolled into surface or with abrasive material metallurgically bonded to steel:
    - a. Manufacturers are subject to compliance with requirements; provide products by one of the following:
      - 1) IKG Industries, a division of Harsco Corporation.
      - 2) SlipNOT Metal Safety Flooring; W.S. Molnar Company.
- H. Steel Tubing: ASTM A 500/A 500M, cold formed steel tubing.
- I. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.
- J. Zinc Coated Steel Wire Rope - ASTM A 741:
  - 1. Wire Rope Fittings: Hot dip galvanized steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
- K. Slotted Channel Framing:
  - 1. Cold formed metal box channels (struts) complying with MFMA-4:
    - a. Size of Channels: 1-5/8 inches by 1-5/8 inches (41 mm by 41 mm).
    - b. Material: Galvanized steel, ASTM A 653/A 653M, commercial steel, Type B, with G90 (Z275) coating; [0.108 inch (2.8 mm) nominal thickness.
    - c. Cold Formed Metal Channels: Flange edges returned toward web and with 9/16 inch (14.3 mm) wide slotted holes in webs at 2 inches (51 mm) o.c.
    - d. Width of Channels: 1-5/8 inches (41 mm).
    - e. Depth of Channels: Indicated on Drawings.
    - f. Metal and Thickness: Galvanized steel complying with ASTM A 653/A 653M, structural quality, Grade 33 (Grade 230), with G90 (Z275) coating; 0.108 inch (2.8mm) nominal thickness.
    - g. Finish: Hot dip galvanized after fabrication.
- L. Aluminum Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
- M. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
- N. Aluminum Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.
- O. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.
- P. Fasteners:
  - 1. Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required:
    - a. Provide stainless steel fasteners for fastening stainless steel.
    - b. Provide bronze fasteners for fastening bronze.
    - c. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
    - d. Steel Bolts and Nuts: Regular hexagon head bolts, ASTM A 325, Type 3 (ASTM A 325M, Type 3); with hex nuts, ASTM A 563, Grade C3 (ASTM A 563M, Class 8S3); and, where indicated, flat washers.
    - e. Stainless Steel Bolts and Nuts: Regular hexagon head annealed stainless steel bolts, ASTM F 593 (ASTM F 738M); with hex nuts, ASTM F 594 (ASTM F 836M); and, where indicated, flat washers; Alloy.



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- f. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
- g. Hot dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- h. Anchors: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
- i. Post Installed Anchors - Per drawings:
  - 1) Material for Interior Locations: Carbon steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
  - 2) Material for Exterior Locations and Where Stainless Steel Is Indicated: ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

Q. Miscellaneous Materials:

- 1. Shop Primer for Ferrous Metal: Universal primer, organic zinc rich primer, complying with SSPC-Paint 20 and compatible with topcoat. Provide 10-99 (red) or 10-09 (gray) by Tnemec Company.
- 2. Universal Shop Primer: Fast curing, lead and chromate free, universal modified alkyd primer and compatible with topcoat. Use primer containing pigments that make it easily distinguishable from zinc rich primer.
- 3. Water Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel and compatible with topcoat.
- 4. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc coated metal and compatible with finish paint systems indicated.
- 5. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in steel, complying with SSPC-Paint 20. Provide Tnemec-Zinc 90-97 by Tnemec Company.
- 6. Bituminous Paint: Cold applied asphalt emulsion complying with SSPC-Paint 12, containing no asbestos fibers, or cold applied asphalt emulsion complying with ASTM D 1187 ASTM D 1187/D 1187M.
- 7. Nonshrink, Nonmetallic Grout: Factory packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- 8. Concrete Materials and Properties: Composed of ASTM C150 Type I Portland cement, ASTM C33 sand and coarse aggregates and potable water to produce a low slump mix suitable for placement. Grade coarse aggregate from 1/8" with at least 95 % passing a 3/8" sieve and not more than 10% passing a No. 8 sieve. Fill shall be proportioned to provide a minimum 28 day compressive strength of 3000 psi (20 MPa).

## 2.2 FABRICATION

A. Shop Assembly:

- 1. Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation:
  - a. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
  - b. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
  - c. Form exposed work with accurate angles and surfaces and straight edges.
  - d. Weld corners and seams continuously to comply with the following:
    - 1) Use materials and methods that minimize distortion and develop strength

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- and corrosion resistance of base metals.
    - 2) Obtain fusion without undercut or overlap.
    - 3) Remove welding flux immediately.
    - 4) At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
  - e. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
  - f. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
  - g. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
  - h. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
  - i. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 inch by 1-1/2 inches (3.2 mm by 38 mm), with a minimum 6 inch (150 mm) embedment and 2 inch (50 mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.
- B. Miscellaneous Framing and Supports:
- 1. Provide steel framing and supports necessary to complete the work and which are not a part of the structural framework, including but not limited to framing and supports for, overhead lobby door frames, sliding doors, countertop and vanities, ceiling hung toilet compartments, and tube framing for partial height walls, mechanical and electrical equipment:
    - a. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction. Cut, drill, and tap units to receive hardware, hangers, and similar items:
      - 1) Fabricate units from slotted channel framing where indicated.
      - 2) Furnish inserts for units installed after concrete is placed.
- C. Shelf Angles:
- 1. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4 inch (19 mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) o.c., unless otherwise indicated:
    - a. Provide mitered and welded units at corners.
    - b. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches (50 mm) larger than expansion or control joint.
    - c. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
    - d. Galvanize and prime shelf angles located in exterior walls.
    - e. Prime shelf angles located in exterior walls with zinc rich primer.
    - f. Furnish wedge type concrete inserts, complete with fasteners, to attach shelf angles to cast in place concrete.

## 2.3 MISCELLANEOUS STEEL TRIM

- A. Miscellaneous Steel Trim:
- 1. Unless otherwise indicated, fabricate units from structural steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges.

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Miter corners and use concealed field splices where possible:

- a. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work:
  - 1) Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction, spaced not more than 6 inches (150 mm) from each end, 6 inches (150 mm) from corners, and 24 inches (600 mm) o.c.
- b. Cast in Pit Angles and Edge Angles: Provide edge angles, and pit angles, fabricated from angles of size as shown, or required, with welded on stud anchors spaced 24 inches (600 mm) on center. Provide pit and edge angles in as long lengths as possible. Miter and weld corners and provide splice plates for alignment between sections.
- c. Galvanize miscellaneous steel trim.

## 2.4 FABRICATION TOLERANCES

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

## 2.5 FINISHES

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

## 2.6 STEEL AND IRON FINISHES

- A. Galvanizing:
  1. Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products:
    - a. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
- D. Preparation for Shop Priming:
  1. Prepare surfaces to comply with requirements indicated below:
    - a. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    - b. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    - c. Other Items: SSPC-SP 3, "Power Tool Cleaning."
- E. Shop Priming:
  1. Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1:

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Shop, Field, and Maintenance Painting of Steel," for shop painting:

- a. Stripe paint corners, crevices, bolts, welds, and sharp edges.

F. Stainless Steel Finishes:

1. Remove tool and die marks and stretch lines or blend into finish:
  - a. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
  - b. Bright, Directional Polish: No. 4 finish.
  - c. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

## 2.7 ALUMINUM FINISHES

A. As-Fabricated Finish - AA-M12.

B. Clear Anodic Finish - AAMA 611, Class I, AA-M12C22A41:

1. Class I, Clear Anodic Finish:
  - a. AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated.
  - b. Chemical Finish: etched, medium matte.
  - c. Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 607.1.

## PART 3 EXECUTION

### 3.1 FIELD CONDITIONS

A. Field Measurements:

1. Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication:
  - a. Established Dimensions: Where field measurements cannot be made without delaying the work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
  - b. Provide allowance for trimming and fitting at site.

### 3.2 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

### 3.3 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that

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are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

- C. Field Welding:
  - 1. Comply with the following requirements:
    - a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
    - b. Obtain fusion without undercut or overlap.
    - c. Remove welding flux immediately.
    - d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Corrosion Protection:
  - 1. Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
    - a. Cast Aluminum: Heavy coat of bituminous paint.
    - b. Extruded Aluminum: Two coats of clear lacquer.

### **3.4 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS**

- A. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.

### **3.5 ERECTION TOLERANCES**

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

### **3.6 ADJUSTING AND CLEANING**

- A. Touchup Painting:
  - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop painted surfaces:
    - a. Apply by brush or spray to provide a minimum 2.0 mil (0.05 mm) dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 90 00: Painting and Coating.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair

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galvanizing to comply with ASTM A 780/A 780M.

**END OF SECTION 05 50 00**

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## **SECTION 05 52 00 METAL RAILINGS**

### **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 requirements for, but is not limited to:
  - 1. Steel pipe and tube railings.
- B. Related Sections:
  - 1. Section 32 13 13: Concrete Paving

#### **1.3 SUBMITTALS**

- A. Product Data:
  - 1. Technical data for railings and the following:
    - a. Manufacturer's product lines of mechanically connected railings.
    - b. Railing brackets.
    - c. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Samples:
  - 1. For each type of exposed finish required:
    - a. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
    - b. Fittings and brackets.
    - c. Assembled sample of railing system, made from full size components, including top rail, post, handrail, and infill. Sample need not be full height:
      - 1) Show method of connection and finishing members at intersections.
- D. Delegated Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Qualification Data: For testing agency.
- F. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
- G. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E894 and ASTM E935.
- H. Evaluation Reports: For post installed anchors, from ICC-ES.

#### **1.4 QUALITY ASSURANCE**

- A. Regulatory Requirements:
  - 1. Accessibility requirements - comply with applicable requirements:
    - a. Americans with Disabilities Act of 1990, as amended:

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- 1) ADA Title II Regulations and the 2016 ADA Standards for Accessible Design.
- b. 2019 California Building Code (CCR Title 24, Part 2, as adopted and amended by DSA):
  - 1) Chapter 10 – Means of Egress:
    - a) Section 1014 Handrails.
    - b) Section 1015.3 Guards.
  - 2) CBC Section 11B-505, Access to Public Buildings, Public Accommodations, Commercial Buildings and Public Housing.
2. Welding qualifications - qualify procedures and personnel according to the following:
  - a. AWS D1.1/D1.1M Structural Welding Code – Steel.

B. Source Limitations: Obtain each type of railing from single source from single manufacturer.

## 1.5 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer licensed in the State of California and experienced in the design of railings, including attachment to building construction.
- B. Structural Performance:
  1. Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
    - a. Handrails and top rails of guards:
      - 1) Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
      - 2) Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      - 3) Uniform and concentrated loads need not be assumed to act concurrently.
      - 4) Design shall comply with the CBC Live Loads Section 1607A.8 CBC. Table 1607A.1 (15).
    - b. Infill of guards:
      - 1) Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of one square foot (0.093 sq. m).
      - 2) Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements:
  1. Allow for thermal movements from ambient and surface temperature changes:
    - a. Temperature change: 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C, material surfaces).
- D. Accessibility Requirements:
  1. Railings and handrails - according to CBC Section 11B-504:
    - a. Top of handrails shall be a consistent vertical height between 34 inches and 38 inches above walking and ramp surfaces, and stair nosing.
    - b. A minimum clearance of 1-1/2 inches between handrail gripping and adjacent surfaces shall be maintained:
      - 1) Handrail may be in a recess if recess depth is a maximum of three inches (3") and there is a minimum of 18 inches clearance above the top of the handrail.
    - c. Handrail gripping shall be continuous and unobstructed. Bottoms of gripping surfaces shall not be obstructed for more than 20 percent of their length. Where provided, horizontal projections shall occur 1-1/2 inches minimum below the bottom of the handrail gripping surfaces:
      - 1) Outside diameter of handrail gripping surfaces with a circular cross section shall be between 1-1/4 inches and two inches (2").
    - d. Outside diameter of handrail gripping surfaces with a non-circular cross section shall be between four inches (4") and 6-1/4 inches, with a maximum cross-



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- sectional dimension of 2-1/4 inches.
- e. Handrail gripping and adjacent surfaces shall be free of sharp and abrasive elements and have rounded edges.
- f. Handrails shall be fixed and not able to rotate within their fittings.
- g. 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.
- h. The orientation of at least one (1) handrail shall be in the direction of the stair run, perpendicular to the direction of the stair nosing, and shall not reduce the minimum required width of the stair, in accordance with CBC Section 11B-505.2.1.
- i. A two-inch (2") minimum high curb or barrier shall be provided to prevent the passage of a four-inch (4") diameter sphere from rolling off the edges on a ramp or landing surface. Such a curb or barrier shall be continuous and uninterrupted along the length of a ramp, in accordance with CBC Section 11B-405.9.2.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Manufacturers are subject to compliance with requirements; provide products by the following:
  - 1. Steel pipe and tube railings: Industrial Metal Supply Co. 1-818-729-3333.
- B. Metal Surfaces: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- C. Brackets, Flanges, and Anchors:
  - 1. Formed metal of same type of material and finish as supported rails unless otherwise indicated:
    - a. Provide type of bracket with predrilled hole for exposed bolt anchorage and that provides 1-1/2-inch (38 mm) clearance from inside face of handrail to finished wall surface.
- D. Steel and Iron:
  - 1. Tubing: ASTM A500 (cold formed) or ASTM A513.
  - 2. Pipe: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
  - 3. Plates, shapes, and bars: ASTM A36/A36M.
- E. Fasteners:
  - 1. Provide the following:
    - a. Ungalvanized steel railings: Plated steel fasteners complying with ASTM B633 or ASTM F1941, Class Fe/Zn 5 for zinc coating.
    - b. Hot dip galvanized railings: Type 304 stainless steel or hot dip zinc coated steel fasteners complying with ASTM A153/A153M or ASTM F2329 for zinc coating.
    - c. Provide exposed fasteners with finish matching appearance, including color and texture of railings.
    - d. Fasteners for anchoring railings to other construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to

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other types of construction indicated and capable of withstanding design loads.

e. Fasteners for interconnecting railing components:

- 1) Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
- 2) Provide tamper resistant hex socket flat head machine screws for exposed fasteners unless otherwise indicated.

F. Miscellaneous Materials:

1. Welding rods and bare electrodes: Select according to AWS specifications for metal alloy welded.
2. Etching cleaner for galvanized metal: Complying with MPI#25.
3. Galvanizing repair paint: High zinc dust content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
4. Shop primer for ferrous metal: Universal primer, organic zinc rich primer, complying with SSPC-Paint 20 and compatible with topcoat. Provide 10-99 (red) or 10-09 (gray) by Tnemec Company.
5. Universal shop primer: Fast curing, lead and chromate free, universal modified alkyd primer and compatible with topcoat. Use primer containing pigments that make it easily distinguishable from zinc rich primer.
6. Shop primer for galvanized steel: Primer formulated for exterior use over zinc coated metal and compatible with finish paint systems indicated.
7. Galvanizing repair paint: High zinc dust content paint for regalvanizing welds in steel, complying with SSPC-Paint 20. Provide Tneme-Zinc 90-97 by Tnemec Company.
8. Bituminous paint: Cold applied asphalt emulsion complying with SSPC-Paint 12, containing no asbestos fibers, or cold applied asphalt emulsion complying with ASTM D1187/D1187M.
9. Non-shrink, nonmetallic grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

## 2.2 FABRICATION

- A. Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with either welded or non-welded connections unless otherwise indicated.

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- H. Welded Connections:
  - 1. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings:
    - a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
    - b. Obtain fusion without undercut or overlap.
    - c. Remove flux immediately.
    - d. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
  - 2. Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
- I. Non-Welded Connections:
  - 1. Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints:
    - a. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- J. Form Changes in Direction:
  - 1. As detailed.
  - 2. Inserting prefabricated elbow fittings.
- K. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- L. Close exposed ends of railing members with prefabricated end fittings.
- M. Provide wall returns at ends of wall mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.
- N. Brackets, Flanges, Fittings, and Anchors:
  - 1. Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated:
    - a. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
- P. For railing posts set in concrete, provide steel sleeves not less than six inches (150 mm) long with inside dimensions not less than 1/2-inch (13 mm) greater than outside dimensions of post, with metal plate forming bottom closure.
- Q. For removable railing posts, fabricate slip fit sockets from steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than 1/40 of post height. Provide socket covers designed and fabricated to resist being dislodged.
- R. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open sided floors and platforms. Fabricate to dimensions and details indicated.

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## **2.3 FINISHES**

- A. Steel and Iron Finishes:
  - 1. Galvanized railings:
    - a. Hot dip galvanize exterior steel railings, including hardware, after fabrication.
    - b. Comply with ASTM A123/A123M for hot dip galvanized railings.
    - c. Comply with ASTM A153/A153M for hot dip galvanized hardware.
    - d. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
  - 2. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
  - 3. Do not apply primer to galvanized surfaces.

## **PART 3 EXECUTION**

### **3.1 COORDINATION**

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

### **3.2 FIELD CONDITIONS**

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.
- B. Grade elevation review to actual conditions.

### **3.3 EXAMINATION**

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for installer. Locate reinforcements and mark locations if not already done.

### **3.4 INSTALLATION**

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation, measured from established lines and levels and free of rack:
  - 1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
  - 2. Set posts plumb within a tolerance of 1/16 inch in three feet (2 mm in 1 m).
  - 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (6

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mm in 3.5 m).

- C. Control of Corrosion:
  - 1. Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials:
    - a. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

### 3.5 RAILING CONNECTIONS

- A. Non-welded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections whether welding is performed in the shop or in the field.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip joint internal sleeve extending two inches (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within six inches (150 mm) of post.

### 3.6 ANCHORING POSTS

- A. Use metal sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with non-shrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Form or core drill holes not less than five inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
- C. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material.
- D. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members:
  - 1. For aluminum pipe railings, attach posts using fittings designed and engineered for this purpose.
  - 2. For stainless steel pipe railings, weld flanges to post and bolt to supporting surfaces.
  - 3. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.
- E. Install removable railing sections, where indicated, in slip fit metal sockets cast in concrete.

### 3.7 ATTACHING RAILINGS

- A. Anchor railing ends at walls with round flanges anchored to wall construction and to railing

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ends using non-welded connections.

- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and connected to railing ends using non-welded connections.
- C. Attach railings to wall with wall brackets, except where end flanges are used. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- D. Secure wall brackets and railing end flanges to building construction as follows:
  - 1. For concrete and solid masonry anchorage, use drilled in expansion shields and hanger or lag bolts.

### **3.8 ADJUSTING AND CLEANING**

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

### **3.9 PROTECTION**

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

**END OF SECTION 05 52 00**

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## **SECTION 06 10 00 ROUGH CARPENTRY**

### **PART 1 GENERAL**

#### **1.1 DESCRIPTION**

- A. Work Included: Provide and install wood framing, sheathing, furring and other rough carpentry as indicated on the Drawings, specified herein, and as needed for a complete and proper installation.
- B. Related Work:
  - 1. Documents affecting work of this Section include, but are not necessarily limited to the County's administrative requirements.
  - 2. Section 06 20 00: Finish Carpentry.
  - 3. Section 06 41 00: Architectural Wood Casework.

#### **1.2 REFERENCES**

- A. ASME B18.2.1 - Square and Hex Bolts and Screws.
- B. APA (The Engineered Wood Association) - Engineered Wood Construction Guide.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- D. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- E. ASTM F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
- F. AWWA C2 - Lumber, Timbers, Bridge Ties and Mine Ties-Preservative Treatment by Pressure Processes.
- G. AWWA C31 - Lumber Used Out Of Contact with the Ground and Continuously Protected from Liquid Water-Treatment by Pressure Processes.
- H. C.B.C. (California Building Code) 2013 Edition.
- I. FS UU-B-790 - Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellent, and Fire Resistant).
- J. Redwood Inspection Service - Standard Specifications for Grades of California Redwood Lumber.
- K. WCLIB - West Coast Lumber Inspection Bureau.
- L. WWPA (Western Wood Products Association) - Western Lumber Product Use Manual.

#### **1.3 QUALITY ASSURANCE**

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

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- B. Codes and Standards: In addition to complying with pertinent codes and regulations of governmental agencies having jurisdiction, unless otherwise specifically directed or permitted by the Architect comply with the following.
  - 1. "Western Lumber Product Use Manual" of the WWPAA for selection and use of products included in that manual.
  - 2. "Engineered Wood Construction Guide" of the APA.
  - 3. "Standard Specifications for Grades of California Redwood Lumber" of the Redwood Inspection Service, when Redwood is used.

#### 1.4 PRODUCT HANDLING

- A. Comply with pertinent provisions of the County's administrative requirements.
- B. Protection: Carefully pile lumber off the ground. Cover all materials and protect from weather.

### PART 2 PRODUCTS

#### 2.1 GRADE STAMPS

- A. Identify framing lumber by the grade stamp of the WCLIB, or such other grade stamp as is approved in advance by the Architect.
- B. Identify plywood as to species, grade, and glue type by the stamp of the APA.

#### 2.2 MATERIALS

- A. Provide materials in the quantities needed for the Work shown on the Drawings, and meeting or exceeding the following standards of quality:
  - 1. Minimum Lumber Grades (with structural grades noted on Structural Drawings):
    - a. 2 x Studs Douglas Fir #1
    - b. 2 x Studs in walls taller than or equal to 12'-0" Douglas Fir #1
    - c. 2 x 4 and deeper Douglas Fir #1
    - d. 4 x in non-load bearing walls Douglas Fir #1
    - e. All other 4 x Beams Douglas Fir #1
    - f. 4 x Posts Douglas Fir #1
    - g. All 6 x and larger Douglas Fir #1
    - h. All furring Douglas Fir construction grade
  - 2. All Sill Plates Bearing on Concrete or Masonry: Pressure treated Douglas Fir.
  - 3. Plywood: Standard sheathing with exterior glue. PS 1-95 with factory grading mark, as noted on Drawings.
  - 4. Wood Preservative:
    - a. Preservative chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium.
    - b. No materials to contain added urea-formaldehyde.
    - c. Preservative Treatment by Pressure Process: AWPA U1, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).
  - 5. Rough Hardware:
    - a. Steel Items:
      - 1) Comply with ASTM A36.
      - 2) Use galvanized at exterior locations.
    - b. Machine Bolts: Comply with ASTM A307.
    - c. Lag Bolts: Comply with ASME B18.2.1.
    - d. Nails:



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- 1) Use common except as otherwise noted.
  - 2) Comply with ASTM F1667.
  - 3) Use galvanized at exterior locations.
6. Building Paper: Kraft paper complying with FS UU-B-790.

## **2.3 OTHER MATERIALS**

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect.

## **PART 3 EXECUTION**

### **3.1 SURFACE CONDITIONS**

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

### **3.2 WORKMANSHIP**

- A. Carefully lay out, fit, and erect all framing plumb and level.
- B. Produce joints which are tight, true, and well nailed, with members assembled in accordance with the Drawings and with pertinent codes and regulations.

### **3.3 GENERAL FRAMING**

- A. General:
1. In addition to framing operations normal to the fabrication and erection indicated on the Drawings, install all wood blocking, backing, and framing required for the work of other trades.
  2. Bearing studs may be notched to a depth not exceeding 1/4 its width but no closer than 5/8" to the edge of the stud.
  3. Non-bearing studs may be notched to a depth not exceeding 40% of its width of bored to 60% of its width but not closer than 5/8" to the edge of the stud.
- B. Bracing:
1. Brace all walls not solidly sheathed with 1 x 6 diagonal bracing at each end and at 25 feet on center.
  2. Adequately brace structure as erection progresses.

### **3.4 BLOCKING**

- A. Install blocking as required to support items of finish and to cut off concealed draft openings, both vertical and horizontal, between all ceiling and floor areas.
- B. Install solid blocking between joists at points of support and wherever sheathing is discontinuous. Blocking may be omitted where joists are supported on metal hangers.

### **3.5 ALIGNMENT**

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- A. On framing members to receive a finished surface, align the finish subsurface to vary not more than 1/8" from the plane of surfaces of adjacent furring and framing members.

### **3.6 INSTALLATION OF PLYWOOD SHEATHING**

- A. Placement: Place plywood with face grain perpendicular to supports and continuously over at least two supports, except where otherwise shown on the Drawings.

### **3.7 FASTENING**

- A. Nailing:
  - 1. Use only Common wire nails or spikes of the dimension shown on the Nailing Schedule, except where otherwise specifically noted on the Drawings.
  - 2. Use untreated steel nails for interior work and concealed framing, and galvanized nails for all exposed exterior work.
  - 3. Use nails long enough to penetrate at least one-half thickness of material.
  - 4. Remove split members and replace with members complying with the specified requirements.
- B. Bolts and Screws:
  - 1. Drill holes 1/16" larger in diameter than the bolts being used.
  - 2. Drill straight and true from one side only.
  - 3. For lag screws and wood screws, pre-bore holes same diameter as root of threads, enlarging holes to shank diameter for length of shank.
  - 4. Screw, do not drive, lag screws and wood screws.

### **3.8 NAILING SCHEDULE**

- A. Unless otherwise directed by the Architect, comply with the nailing schedule on drawings and other fastening requirements contained in the pertinent regulations of governmental agencies having jurisdiction.

### **3.9 CLEANUP**

- A. Broom clean inside and out, removing from the site all scraps and other debris left or caused by this work.

**END OF SECTION 06 10 00**

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## **SECTION 06 20 00 FINISH CARPENTRY AND MILLWORK**

### **PART 1 GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Providing all finish carpentry items including, but not limited to:
    - a. Finish Carpentry
    - b. Millwork and Cabinetry
    - c. Plastic Laminate
    - d. Casework Hardware
    - e. Miscellaneous Millwork
  - 2. Installation of:
    - a. Finish hardware
    - b. Plastic laminate faced wood doors
- B. Related Sections:
  - 1. Section 06 10 00: Rough Carpentry.
  - 2. Section 09 21 16: Gypsum Board Assemblies.
- C. Reference Standards:
  - 1. Codes and References:
    - a. 2019 California Building Code Section 11B-309.
    - b. American Disabilities Act Design Guidelines (ADADG).
  - 2. American National Standards Institute:
    - a. ANSI A156.9 - Cabinet Hardware
    - b. ANSI A161.1 - Woodwork Testing Standards
    - c. ANSI A208.1 - Mat-Formed Wood Particleboard.
  - 3. Woodwork Institute:
    - a. WI – North American Architectural Woodwork Standards (min 2017 Ed.)
  - 4. National Electrical Manufacturers Association:
    - a. NEMA LD 3 - High Pressure Decorative Laminates.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Unless otherwise indicated, perform work in accordance with WI "Architectural Woodwork Standards", Custom Grade, except where specification exceeds those standards, the more stringent shall govern.
- B. Fabricate millwork and cabinetry in accordance with ANSI A161.1, NEMA LD3, and general static load testing performed and certified by an independent testing agency, covering the following areas of product performance, with these minimum results:
  - 1. Base cabinet construction/racking test: 800 lbs.
  - 2. Cabinet front joint loading test: 425 lbs.
  - 3. Wall cabinet static load test: 2,000 lbs.
  - 4. Drawer front joint loading test: 600 lbs.
  - 5. Drawer construction/static load test: 750 lbs.
  - 6. Cabinet adjustable shelf support device/static load test: 300 lbs.

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- C. Shelf Loading: Comply with loading/deflection standards of the Composite Panel Association.

#### 1.4 SUBMITTALS

- A. Product Data:
  - 1. Manufacturer's specifications and other data needed to prove compliance with specified requirements.
  - 2. Manufacturer's preprinted product information for all hardware proposed on the project.
  - 3. Manufacturer's preprinted maintenance instructions for the casework hardware.
- B. Shop Drawings:
  - 1. Indicate size, material and finish.
  - 2. Show locations and installation procedures, including hardware, sinks, service fixtures, trim and other pertinent data for each unit.
- C. Certification: Provide manufacturer's certification that casework has been fabricated and installed according to WI "Custom" Grade guidelines or better.
- D. Samples: Two (2) each, 6 inch by 6 inch by 3/4 inch sample of specified particleboard core with grade stamp for use as verification of installed product.
- E. Closeout:
  - 1. Record Drawings: Indicate revisions to original drawings and shop drawings.
  - 2. Manufacturer contact names, addresses and phone numbers.
  - 3. Finish Material Schedule: names and color numbers of laminates and stains.
  - 4. Keys: Provide additional master key for each room and additional locksets totaling one percent of total project for attic stock.

#### 1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a licensee of WI's Certified Compliance Program.
- B. Installer Qualifications: Licensee of WI's Certified Compliance Program.
- C. Quality Standard:
  - 1. Unless otherwise indicated, comply with WI's "Manual of Millwork" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements:
    - a. Before delivery to job-site, Millwork supplier:
      - 1) Licensees of WI shall issue a certified compliance certificate indicating millwork products being furnished for this project, and certifying that these products and their installation, will fully meet requirements of grade or grades specified.
      - 2) Non-Licensees of WI shall provide evidence that they have arranged for inspection by WI inspector after completion of fabrication and installation. If conditions are found to be compliant, inspector will issue Compliance Certificate indicating millwork products being furnished for this project, and certifying that these products and their installation, will fully meet requirements of grade or grades specified.
    - b. Each elevation of casework and each countertop shall bear certified compliance label.
    - c. Cabinet Design Series (CDS): CDS numbers on Drawings indicate typical designs.

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- D. Certified Seismic Installation Program (CSIP):
  - 1. Before wood or metal stud walls are closed up provide a written Woodwork Institute Certified Seismic Installation Program (CSIP) report confirming that acceptable backing is provided in all locations required for casework installation or identifying those locations where backing is missing or improperly located:
    - a. Backing shall consist of a minimum of either 3 x 6 Flat Douglas Fir or 16GA. 50 KSI sheet metal.
  - 2. On completion of installation provide a Woodwork Institute Certified Seismic Installation Program Certificate, identifying the work covered and certifying that installation meets the requirements of the WI CSIP attachment details and schedules.
  - 3. All fees charged by the Woodwork Institute for their Certified Seismic Installation Program are the responsibility of the millwork installer and shall be included in their bid.
- E. Pre-installation Conference:
  - 1. See Section 01 31 00: Project Management and Coordination.

## 1.6 WARRANTY

- A. Warranty the work specified herein for five (5) years against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.
- B. Defects shall include, but not be limited to the following:
  - 1. Rough or difficult operation, or loose or missing parts.
  - 2. Delamination of surfaces.
  - 3. Noticeable deterioration of finish.
  - 4. Warped or misaligned surfaces or telegraphing of subsurface imperfections.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver completed laminate clad casework, countertops and related products only after wet operations in building are completed. Store in ventilated place, protected from the weather, with relative humidity range of 20 to 50 percent.
- B. Protect finished surfaces from soiling and damage during handling and installation with a protective covering.

## PART 2 PRODUCTS

### 2.1 MILLWORK MANUFACTURERS

- A. Woodwork Institute listed Accredited Millwork Companies 2019 Roster and shall not preclude the Contractor from using other manufacturers, provided they produce equivalent products of the type specified for the scope and size of the Project. Other manufacturers must have experience manufacturing products meeting or exceeding the specifications and must comply with the criteria specified in paragraph 1.6 above and with Division 01 requirements regarding substitutions.

### 2.2 MILLWORK MATERIALS

- A. Plastic Laminate:
  - 1. High-pressure decorative laminate (HPDL) complying with NEMA LD3, and the following requirements:
    - a. Exterior Color Selection Available:

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- 1) Architect to select from minimum of 250 selections available, including wood grain patterns and solid colors.
- 2) If laminate has wood grain, direction of grain shall be vertical on door, end panels, fascia panels, and exposed backs; horizontal on drawer faces, aprons, and top rails.
2. Laminate grades:
  - a. Exposed doors, finished end panels, and other vertical surfaces: GP28 (0.028 inch thick nominal)
  - b. Horizontal surfaces other than top: GP28 (0.028 inch thick nominal)
  - c. Cabinet Liner: CL20 (0.020 inch nominal), white.
  - d. Work Surfaces and Countertops: GP50 (0.050 inch thick nominal) with BK20 (0.20 inch thick) backer sheet.
  - e. Backsplash: PH42 (0.042 inch nominal) with nominally balanced backer sheet.
3. Adhesive: PVA water resistant adhesive. Contact adhesives not permitted.
4. Pressure Fused Laminate:
  - a. NEMA LD3 VGL, and NEMA LD3 CLS, Melamine resin impregnated, 120 gram PSM minimum, thermofused to core under pressure.
  - b. Color:
    - 1) Closed interiors, underside of wall cabinets: White.
    - 2) Exposed and Semi-exposed open cabinets: Match exterior.
  - c. Provide balanced construction with same thermofused melamine. Unsurfaced coreboard or simple backers not allowed.
- B. Core Material:
  1. Particleboard: ANSI 208.1, Grade M-2-Exterior Glue.
  2. Medium-Density Fiberboard: ANSI A208.2, Grade MD.
  3. Plywood: Shop sanded, exterior grade veneer cored, hardwood faced, any species, with no defects affecting strength or utility. Overlay plywood not permitted. Plywood allowed at countertops and toe-base only.
  4. Water resistant treated plywood: shall have 24 hour thickness swell factor of five percent or less and 24 hour water absorption factor of ten percent or less; P.S. 51, Type II or better.
  5. Cabinet components shall be of the following minimum core thicknesses:
    - a. Cabinet backs, drawer body, and drawer bottoms: 1/2 inch particleboard
    - b. Door and drawer face, base, wall, and tall cabinet tops and bottoms, cabinet sides, drawer spreaders, cabinet back rear hangstrips, structural dividers, and exposed cabinet backs: 3/4 inch particleboard
    - c. Work surfaces and countertops: minimum 1 inch particleboard or plywood, except use water resistant treated plywood core at counters with sinks.
    - d. Shelves: 3/4 inch particleboard core for 30 inches long or less, 1 inch thick particleboard core for more than 30 inches long; 14 inch deep, unless otherwise noted. Provide vertical dividers for shelves over 36 inches long.
    - e. Cabinet Toe-Base: 3/4 inch plywood. No particleboard within four (4) inches of floor.
    - f. Wood from old growth forests are not permitted.
- C. Countertops and Backsplashes:
  1. Countertops: Provide countertops with PVC edge in as long as practical continuous lengths. Provide field glued splines at joints. No joints closer than 24 inches either side of sink cutout.
  2. Backsplash: Integral to countertop, 4 inch high unless otherwise shown. Fabricate with single continuous sheet of laminate from front counter to top of splash with no joints from horizontal to vertical application. No joints shall occur at sink openings.
  3. At exposed countertop end corners, provide 1 inch radius, or similar safety treatment.
- D. Toe Spaces: Leave toe spaces unfinished for installation of resilient base, unless otherwise

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shown.

- E. End Panels and Filler Strips: Match adjacent case-piece.
- F. Edging:
  - 1. Provide the following in accordance with "Edging Locations:"
    - a. Flat Edge PVC: 0.020 inch. Solid, high-impact, purified, color-thru, acid resistant, machine-applied with hot melt adhesives.
    - b. 3 mm PVC: Solid, high-impact, purified, color-thru, acid resistant, pre-lamination primed edging, machine-applied with hot melt adhesives, and machine profiled to 1/8 inch radius.
  - 2. Edging Locations:
    - a. Cabinet body edge, including door/drawer front spacer rail: Flat Edge PVC, color matched to door/drawer face or as selected.
    - b. Forward edge of interior body components, interior dividers, shelf, and top edges of drawer body: Flat Edge PVC to match cabinet interior surface color.
    - c. Door/Drawer-Front edging: 3mm PVC, color matched to standard laminates.

## 2.3 CABINET HARDWARE

- A. All hardware shall meet ANSI A156.9 and shall be subject to approval by the Architect. All keying shall match existing master key system and be approved by the Owner:
  - 1. Acceptable Manufacturers:
    - a. Knappe & Vogt (District Standard)
    - b. As specified herein, provide specified product, or Architect approved equal.
- B. Hinges:
  - 1. Heavy duty, five-knuckle 2 3/4 inch institutional type hinge shall meet ANSI/BHMA A156.9 Grade 1 requirements. Mill ground, hospital tip, Teflon coated tight pin feature with all edges eased. Hinge shall be full wrap around type of tempered steel 0.095 inch thick. Each hinge shall have minimum of 9 screws, #7, 5/8 inch FHMS to assure positive door attachment.
  - 2. One pair per door to 48 inch height. One and one-half pair over 48 inches in height. Hinge shall accommodate 13/16 thick laminated door and allow 270 degree swing.
  - 3. Finish: US26D.
- C. Pulls: Wire design, 4 inches, Chrome, US26D finish.
- D. Sliding Door Hardware:
  - 1. Frameless 1/4 inch glass sliding doors: double track rolling door assembly.
  - 2. Framed 13/16 inch thick stile and rail sliding doors: top mounted track with dual roller hangers. Vertical adjustment for accurate alignment.
- E. Drawer Slides:
  - 1. Standard Drawers: 3/4 extension, self-closing, white epoxy-coated, lever disconnect, positive in-stop/out-stop, nylon rollers, minimum 100 pound dynamic load rating at full extension.
  - 2. File Drawers: Full extension, 3-part progressive opening slide, precision steel ball bearing, minimum 100 pound dynamic load rating at full extension, zinc plated or epoxy coated at manufacturer's option.
  - 3. Provide body mounted molded rails for hanging file system for legal or letter size as indicated by manufacturer's model number. Cutting or machining of drawer body/face not permitted.
  - 4. Paper Storage Drawers: Full extension, self-closing, white epoxy-coated, lever disconnect, positive in-stop/out-stop, nylon rollers, minimum 150 pound dynamic load rating at full extension.



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- F. Catches:
  - 1. Provide opening resistance in compliance with the Americans with Disabilities Act.
    - a. Provide top-mounted magnetic catch for base and wall cabinet door.
    - b. Provide two at each tall cabinet door. Catch housing shall be molded in White.
- G. Adjustable Shelf Supports:
  - 1. Dual-pin design with anti-tip-up shelf restraints for both 3/4 inch and 1 inch shelves.
  - 2. Include keel to retard shelf slide-off, and slot for mechanical attachment of shelf to clip.
  - 3. Load rating shall be minimum 300 pounds each support without failure.
- H. Wardrobe Rod: 1-1/6 inch diameter plated steel rod, with captive sockets.
- I. Coat Hooks: Single and double prong, wall mount - Satin Aluminum.
- J. Locks: Five-disk tumbler cam-style with strike. Locks on cabinets in same room keyed alike. Provide two (2) keys per room where doors and drawers are scheduled to receive locks. Dull chrome finish. Lock core shall be removable with a control key, permitting Owner to change lock arrangements without tools.

## 2.4 SPECIALTY ITEMS

- A. Grommets:
  - 1. Approved Product/Manufacturer: **Model No. EDP3 manufactured by Doug Mockett & Company, Inc. (basis of design)**, Manhattan Beach, CA; (800) 523-1269, or Architect approved equal.
  - 2. Size: 2-1/2 inches diameter with "Flip-Top"™ tab in cap.
  - 3. Colors: As selected by Architect from manufacturer's available colors.
  - 4. Number/Location: Where electrical, telephone, and computer data wiring need to pass through tops whether shown or not.
- B. Molded Personal Pencil Drawer: High-impact 100 Polystyrene with in-stop, out-stop, and self-closing features. Provide under top mounted 100 lb self-closing slides. Twelve compartment drawer body, and slides, Black. Provide where indicated on plans.

## 2.5 SOLID STOCK

- A. Moisture Content: Percent of moisture in relation to over-dry weight shall be between 8 percent and 13 percent at time of installation.
- B. Natural Finish Hardwood:
  - 1. Occasional knot permitted provided it is tight and smooth.
  - 2. Grain Pattern: Rift-cut
  - 3. Species: WI "Premium" Grade, White Oak
- C. Paint Grade Hardwood: Any species, including Parana Pine, except do not use Oak, Elm or similar species which have coarse grain.

## 2.6 MISCELLANEOUS

- A. Utility Shelving: WI "Economy" grade.
- B. Clothes Rod: 1-1/2 inch diameter smooth wooden dowel by length required, with end supports and fasteners of type recommended to suit application.
- C. Telephone/MDF/IDF Board: Provide minimum 4 foot by 8 foot by 3/4 inch thick plywood for



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telephone/data punch down blocks and video equipment in accordance with Section 06 10 00: Rough Carpentry. Paint in accordance with Section 09 90 00: Painting and Coating.

## 2.7 MILLWORK FABRICATION

- A. Fabricate casework, countertops and related products to dimensions, profiles and details shown on drawings. Fabricate casework square, plumb, and true.
- B. Detailed Requirements For Cabinet Construction:
  1. Toe-Base:
    - a. Continuous, ladder type platform with concealed fastening to cabinet bottom, level and secured to floor
    - b. Toe-base at exposed cabinet end panels shall be recessed 1/4 inch from face of finished end, for flush installation of finished base material.
    - c. No cabinet sides-to-floor will be allowed.
  2. Cabinet Top and Bottom:
    - a. Solid sub-top shall be furnished for all base and tall cabinets.
    - b. At cabinets over 36 inches bottoms and tops shall be mechanically joined by a fixed divider.
    - c. Assembly devices shall be concealed on bottom side of wall cabinets.
  3. Cabinet Sides:
    - a. Doweled, and glued under pressure, or attached with fully concealed interlocking mechanical fasteners to sub-top and bottom.
    - b. Drill holes for adjustable shelves 1-1/4 inches on center.
  4. Cabinet Backs:
    - a. Side bound, captured in grooves, recessed from cabinet rear, and securely fastened at top and bottom.
    - b. Hang rails shall be located at rear of cabinet back and fastened to cabinet sides. Provide minimum of two (2) at base, two (2) at wall, and three (3) at tall cabinets as instructed by casework manufacturer.
    - c. Provide removable back panels and closure panels for plumbing access at all sink cabinets, and where shown on drawings.
  5. Exposed end corner and face frame attachment:
    - a. Butt joint, glued and finish nailed; or attached with fully concealed interlocked mechanical fasteners.
  6. Door and Drawer Fronts:
    - a. Drawer fronts and hinged doors shall overlay the cabinet body. Maintain a maximum 1/8 inch reveal between pairs of doors, between door and drawer front, or between multiple drawer fronts within the cabinet.
    - b. Where indicated, provide Stile and Rail doors with full 1/4 inch plate glass, hinged or sliding. Exposed lite-opening edges shall be trimmed and glazed with extruded glazing bead.
    - c. Where indicated, frameless sliding glass doors shall be 1/4 inch thick plate glass with ground and polished edges. Fit with anodized aluminum shoes and nylon rollers.
- C. Drawers:
  1. Drawer fronts: apply to separate drawer body component sub-front.
  2. Drawer sides: doweled to receive front and back, glued under pressure, machine squared.
  3. Drawer bottom: set into front and sides, 1/4 inch deep groove with minimum 3/8 inch standing shoulder, continuously glued. Reinforce drawer bottoms with 1/2 inch by 4 inch front-to-back intermediate underbody stiffeners, mechanically fastened. One at 24 inches, two at 36 inches, and over.
  4. Paper storage drawers: fitted with full width hood at back.
  5. Hanging file drawers shall be fabricated to accept letter size hanging folders

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compatible with Pendaflex system.

- D. Vertical and Horizontal Dividers: As required by manufacturer for type and style of component.
- E. Door/Drawer Front Rail: As required by manufacturer for type and style of component, and hardware placement.
- F. Accessibility Requirements: 2019 California Building Code, Section 11B: The following special requirements shall be met, where specifically indicated on architectural plans as "Accessible", or by General Note. Shall be in compliance with California title 24 access:
  - 1. Countertop height: With or without cabinet below, not to exceed a height of 34 inches Above Finished Floor (A.F.F.), at a surface depth of 24 inches
  - 2. Kneespace clearance: minimum 29 inches A.F.F. at apron, and 30 inches clear span width.
  - 3. 12 inch deep shelving, adjustable or fixed: Not to exceed a range from 15 inches A.F.F. to 48 inches A.F.F.
  - 4. Wardrobe cabinets: Provide with rod/shelf adjustable to 48 inches A.F.F. at a maximum 21 inch shelf depth.
  - 5. Sink cabinet clearances: In addition to above, upper kneespace frontal depth shall be no less than 8 inches, and lower toe frontal depth shall be no less than 11 inches, at a point 9 inches A.F.F., and as further described in Volume 56, Section 4.19.
- G. Typical Desk or Counter Height at Kneespace Locations: 30" above finished floor.

## **PART 3 EXECUTION**

### **3.1 JOB CONDITIONS**

- A. Environmental Requirements:
  - 1. Do not install casework until permanent HVAC systems are operating and temperature and humidity have been stabilized for at least one (1) week:
    - a. Manufacturer/Supplier shall advise Contractor of temperature and humidity requirements for architectural casework installation areas.
    - b. After installation, control temperature and humidity to maintain relative humidity between 25 and 55 percent.
- B. Conditions: Do not store or install casework in building until concrete, masonry, and drywall/plaster work is dry.

### **3.2 COORDINATION**

- A. Coordinate the Work of this Section with plumbing work specified in Division 22. Coordinate sink opening construction with sinks specified in Division 22.
- B. Coordinate location of blocking in walls for installation and support of wall cabinets.

### **3.3 MILLWORK INSTALLATION**

- A. Positioning: Place approximately level, plumb and at right angles to adjacent work.
- B. Fitting: Where field cutting or trimming is necessary, perform in a neat, accurate, professional manner without damaging the products and adjacent work.
- C. Anchorage: Attach securely so the products will perform to their maximum ability without

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damage from inadequate fastenings.

- D. Fasten tops to frames with concealed clips, screws and glue.
- E. Install simulated wood trim in locations shown on drawings and in accordance with manufacturer's instructions.

### **3.4 FINISH HARDWARE INSTALLATION**

- A. The supplier will mark each item of hardware for location. Protect the markings until each item is installed. If any item is delivered to the job not properly marked, return it to the supplier for marking before attempting to install it.
- B. Check markings on hardware for proper location. Install and make necessary adjustments for proper working order. Any hardware damaged by improper adjustment or careless abuse will be replaced by the Contractor at his expense.
- C. Provide clean, properly sized and accurately placed mortises and drilled holes for all mortise hardware such as locksets and for cylindrical locks where specified only.
- D. Fit all surface-applied hardware accurately.
- E. After hardware is installed, protect exposed surfaces by use of heavy paper and masking tape and maintain until job completion.
- F. Remove all finish hardware except that which is primed for painting before painter's finish is applied. Permanently replace and re-adjust for proper function after painter's finish has dried hard.
- G. Millwork contractor shall be responsible for hardware on millwork.

### **3.5 PLASTIC LAMINATE FACED WOOD DOOR INSTALLATION**

- A. Protect all doors during handling.
- B. Provide locks on all upper and base cabinet doors and drawers.
- C. Install doors in accordance with manufacturer's instructions.
- D. Install and adjust doors for smooth, quite operation.

**END OF SECTION 06 20 00**

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## **SECTION 06 83 16 FIBERGLASS REINFORCED PANELING**

### **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 requirements including but not limited to:
  - 1. Glass Fiber Reinforced Plastic Paneling.
  - 2. Trim accessories.
  - 3. Accessories necessary for a complete installation.
- B. Related Sections:
  - 1. Section 06 10 00: Rough Carpentry.
  - 2. Section 07 92 00: Joint Sealants.
  - 3. Section 09 21 16: Gypsum Board Assemblies.

#### **1.3 SUBMITTALS**

- A. Product Data: Technical data including supporting documentation of compliance with surface burning characteristics for FRP and accessories.

#### **1.4 QUALITY ASSURANCE**

- A. Regulatory Requirements:
  - 1. Building Code: Comply with applicable requirements of the CBC for interior plastic materials and interior wall finishes.
  - 2. Surface Burning Characteristics:
    - a. Determined by testing identical products according to ASTM E 84 by qualified testing agency. Identify products with appropriate markings of applicable testing agency:
      - 1) Flame Spread Index: 25 or less.
      - 2) Smoke Developed Index: 450 or less.
- B. Source Limitations: Obtain plastic paneling and trim accessories from single manufacturer.

### **PART 2 PRODUCTS**

#### **2.1 MATERIALS**

- A. Glass Fiber Reinforced Plastic Paneling:
  - 1. Gelcoat finished, glass fiber reinforced plastic panels complying with ASTM D 5319:
    - a. Provide USDA accepted panels for incidental food contact.
    - b. Manufacturers are subject to compliance with requirements; provide products by one of the following:
      - 1) Marlite (Basis of Design) 1 Marlite Dr, Dover, OH 4462. Ph: 800-377-1221. [www.marlite.com](http://www.marlite.com)
      - 2) Crane Composites, Inc.
      - 3) Glasteel.
      - 4) Nudo Products, Inc.

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- 5) Parkland Plastics, Inc.
- c. Nominal Thickness: Not less than 0.09 inch (2.3 mm).
- d. Surface Finish: smooth (No texture).
- e. Color: Selected by Architect.

## **2.2 ACCESSORIES**

- A. Trim Accessories:
  - 1. One piece vinyl extrusions designed to retain and cover edges of panels. Provide division bars, inside corners, outside corners, and caps as needed to conceal edges.
    - a. Color: Selected by Architect.
- B. Exposed Fasteners: Nylon drive rivets recommended by panel manufacturer.
- C. Concealed Mounting Splines: Continuous, where applicable, H-shaped aluminum extrusions designed to fit into grooves routed in edges of factory laminated panels and to be fastened to substrate.
- D. Adhesive: Recommended by plastic paneling manufacturer.
- E. Sealant: Mildew resistant, single component, neutral curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Section 07 92 00.

## **PART 3 EXECUTION**

### **3.1 PROJECT CONDITIONS**

- A. Environmental Limitations: Do not deliver or install plastic paneling until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

### **3.2 EXAMINATION**

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the work.
- B. Proceed with installation after correcting unsatisfactory conditions.

### **3.3 PREPARATION**

- A. Remove wallpaper, vinyl wall covering, loose or soluble paint, and other materials that might interfere with adhesive bond.
- B. Prepare substrate by sanding high spots and filling low spots as needed to provide flat, even surface for panel installation.
- C. Clean substrates of substances that could impair adhesive bond, including oil, grease, dirt, and dust.
- D. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.
- E. Lay out paneling before installing. Locate panel joints to provide equal panels at ends of walls not less than half the width of full panels so that trimmed panels at corners are not less

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than 12 inches (300 mm) wide:

1. Mark plumb lines on substrate at trim accessory panel joint locations for accurate installation.
2. Locate trim accessories panel joints to allow clearance at panel edges according to manufacturer's written instructions.

### **3.4 INSTALLATION**

- A. Install plastic paneling according to manufacturer's written instructions.
- B. Install panels in a full spread of adhesive.
- C. Install panels with fasteners. Layout fastener locations and mark on face of panels so that fasteners are accurately aligned:
  1. Drill oversized fastener holes in panels and center fasteners in holes.
  2. Apply sealant to fastener holes before installing fasteners.
- D. Install factory laminated panels using concealed mounting splines in panel joints.
- E. Install trim accessories with adhesive and nails NO staples. Do not fasten through panels.
- F. Fill grooves in trim accessories with sealant before installing panels, and bed inside corner trim in a bead of sealant.
- G. Maintain uniform space between panels and wall fixtures. Fill space with sealant.
- H. Maintain uniform space between adjacent panels and between panels and floors, ceilings, and fixtures. Fill space with sealant.
- I. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

**END OF SECTION 06 83 16**

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## **SECTION 07 13 26 SELF ADHERING SHEET WATERPROOFING**

### **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 requirement including but not limited to:
  - 1. Modified bituminous sheet waterproofing.
  - 2. Accessories necessary for a complete installation.

#### **1.3 SUBMITTALS**

- A. Product Data:
  - 1. For each type of product:
    - a. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
    - b. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.
- B. Shop Drawings:
  - 1. Show locations and extent of waterproofing and details of substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions:
    - a. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.
- C. Samples:
  - 1. For each exposed product and for each color and texture specified, including the following products:
    - a. 8-by-8-inch (200-by-200-mm) square of waterproofing and flashing sheet.
    - b. 8-by-8-inch (200-by-200-mm) square of insulation.
    - c. 4-by-4-inch (100-by-100-mm) square of drainage panel.
- D. Qualification Data: For Installer.
- E. Field quality-control reports.
- F. Sample Warranties: For special warranties.

#### **1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: An entity having minimum 5 years documented experience and employs installers and supervisors who are trained and approved by waterproofing manufacturer.
- B. Source Limitations for Waterproofing System: Obtain waterproofing materials from single source from single manufacturer.
- C. Pre-installation Conference:

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1. Conduct conference at site.
2. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

## 1.5 WARRANTY

- A. Written warranty signed by manufacturer in which manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period:
  1. Warranty Period: Five years from date of Substantial Completion.
- B. Written warranty signed by Installer in which Installer agrees to warrant its work:
  1. Warranty Period: Two years from the date of Substantial Completion.
  2. Warranty includes removing and reinstalling protection board, drainage panels, insulation, and pedestals.

## PART 2 PRODUCTS

### 2.1 MODIFIED BITUMINOUS SHEET WATERPROOFING

- A. Modified Bituminous Sheet:
  1. Minimum 60-mil (1.5-mm) nominal thickness, self-adhering sheet consisting of 56 mils (1.4 mm) of rubberized asphalt laminated on one side to a 4-mil (0.10-mm) thick, polyethylene-film reinforcement, and with release liner on adhesive side.
    - a. Manufacturers are subject to compliance with requirements; provide products by one of the following:
      - 1) Carlisle Coatings & Waterproofing Inc.
      - 2) GCP Applied Technologies.
      - 3) Henry Company.
      - 4) Protecto Wrap Company.
      - 5) W. R. Meadows, Inc.
      - 6) Approved equal.
    - b. Physical Properties:
      - 1) Tensile Strength, Membrane: 250 psi (1.7 MPa) minimum; ASTM D 412, Die C, modified.
      - 2) Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
      - 3) Low Temperature Flexibility: Pass at minus 20 degrees F (minus 29 degrees C); ASTM D 1970.
      - 4) Crack Cycling: Unaffected after 100 cycles of 1/8 inch (3-mm) movement; ASTM C 836.
      - 5) Puncture Resistance: 40 lbf (180 N) minimum; ASTM E 154.
      - 6) Water Absorption: 0.2 percent weight-gain maximum after 48-hour immersion at 70 degrees F (21 degrees C); ASTM D 570.
      - 7) Water Vapor Permeance: 0.05 perms (2.9 ng/Pa x s x sq. m) maximum; ASTM E 96/E 96M, Water Method.
    - c. Sheet Strips: Self adhering, rubberized asphalt strips of same material and thickness as sheet waterproofing.

### 2.2 FLEXIBLE FLASHING

- A. Flexible Flashing
  1. Minimum 25-mil (0.64 mm) nominal thickness polyethylene-backed membrane with an aggressive rubberized asphalt/butyl hybrid adhesive.



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- a. Manufacturers are subject to compliance with requirements; provide products by one of the following:
  - 1) Carlisle Coatings & Waterproofing Inc.
  - 2) GCP Applied Technologies.
  - 3) Henry Company.
  - 4) Protecto Wrap Company.
  - 5) W. R. Meadows, Inc.
  - 6) Approved equal.
- b. Basis of Design: Protecto Wrap BT25XL Building Tape
- c. Roll size: 6" x 75', 9" x 75', 12" x 75' (Other sizes available upon request). BT25XL 9" (229 mm) and wider come standard with a 4" (102 mm) custom serration integrated into the release liner.
- d. Weight: 82 lb./ 400 sq. ft. (37.2kg/ 44.4 sq. m).
- e. Color: Light Gray.
- f. Permeance (Perm), also known as Moisture vapor transmission rate: 0.01 grains/hr- sq. ft.-in Hg (1.61 ng/(Pa-s-sq. m)), when tested in accordance with ASTM E 96.
- g. Tensile Strength: 975 psi (6718 kPa), when tested in accordance with ASTM D 412.
- h. Elongation: Over 500% (rubberized adhesive only) when tested in accordance with ASTM D412).
- i. Maximum Exposure time: 120 (days).
- j. Operating Temperature Range: -45 F to 240 F (7 C - 116 C).
- k. Application(s):
  - a. Use on window and door perimeters to the building substrate.

## 2.3 AUXILIARY MATERIALS

- A. Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
- B. Primer: Liquid primer recommended for substrate by sheet waterproofing material manufacturer.
- C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by sheet waterproofing material manufacturer.
- D. Liquid Membrane: Elastomeric, two component liquid, cold fluid applied, of trowel grade or low viscosity.
- E. Substrate Patching Membrane: Low viscosity, two component, modified asphalt coating.
- F. Metal Termination Bars: Aluminum bars, approximately 1 inch by 1/8 inch (25 mm by 3 mm) thick, predrilled at 9 inch (229 mm) centers.
- G. Protection Course:
  1. ASTM D 6506, semirigid sheets of fiberglass or mineral reinforced asphaltic core, pressure laminated between two asphalt saturated fibrous liners and as follows:
    - a. Thickness: 1/8 inch (3 mm), nominal, for vertical applications; 1/4 inch (6 mm), nominal, elsewhere.
    - b. Adhesive: Rubber based solvent type recommended by waterproofing manufacturer for protection course type.

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## **PART 3 EXECUTION**

### **3.1 FIELD CONDITIONS**

- A. Environmental Limitations:
  - 1. Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate:
    - a. Do not apply waterproofing in snow, rain, fog, or mist.
- B. Maintain adequate ventilation during preparation and application of waterproofing materials.

### **3.2 EXAMINATION**

- A. Examine substrates, areas, and conditions for compliance with requirements and conditions affecting performance of the waterproofing:
  - 1. Verify concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
  - 2. Verify substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
- B. Proceed with installation after correcting unsatisfactory conditions.

### **3.3 SURFACE PREPARATION**

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form release agents, paints, curing compounds, and other penetrating contaminants or film forming coatings from concrete.
- D. Remove fins, ridges, mortar, and projections and fill honeycomb, aggregate pockets, holes, and other voids.
- E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.
- F. Bridge and cover isolation joints, expansion joints with overlapping sheet strips of widths according to manufacturer's written instructions:
  - 1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.
- G. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.
- H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to ASTM D 6135.

### **3.4 MODIFIED BITUMINOUS SHEET WATERPROOFING APPLICATION**

- A. Install modified bituminous sheets according to waterproofing manufacturer's written instructions and recommendations in ASTM D 6135.

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- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.
- C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2 inch (64 mm) minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure watertight installation.
- D. Two Ply Application: Install sheets to form a membrane with lap widths not less than 50 percent of sheet widths, to provide a minimum of two thicknesses of sheet membrane over areas to receive waterproofing.
- E. Apply continuous sheets over already installed sheet strips, bridging substrate cracks, construction, and contraction joints.
- F. Seal edges of sheet waterproofing terminations with mastic.
- G. Install sheet waterproofing and auxiliary materials to tie into adjacent waterproofing.
- H. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches (150 mm) beyond repaired areas in all directions.
- I. Immediately install protection course with butted joints over waterproofing membrane:
  - 1. Molded sheet drainage panels may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer and installed immediately.

### **3.5 FIELD QUALITY CONTROL**

- A. Engage a site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish daily reports to Architect.
- B. Engage an independent testing agency to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.
- C. Prepare test and inspection reports.

### **3.6 PROTECTION, REPAIR, AND CLEANING**

- A. Do not permit foot or vehicular traffic on unprotected membrane.
- B. Protect waterproofing from damage and wear during remainder of construction period.
- C. Protect installed board insulation and insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- D. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.
- E. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

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**END OF SECTION 07 13 26**

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## **SECTION 07 21 00 THERMAL 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 requirements including but not limited to:
  - 1. Glass fiber blanket.
  - 2. Acoustical Insulation.
  - 3. Accessories necessary for a complete installation.
- B. Related Sections:
  - 1. Section 06 10 00: Rough Carpentry.
  - 2. Section 09 21 16: Gypsum Board Assemblies.

#### **1.3 SUBMITTALS**

- A. Product Data: Technical data and installation instructions for each type of insulation product specified.

#### **1.4 QUALITY ASSURANCE**

- A. Regulatory Requirements:
  - 1. Fire Performance Characteristics - Identify products with appropriate markings of applicable testing and inspecting organization:
    - a. Surface Burning Characteristic: ASTM E 84.
    - b. Flame Spread Index: Maximum 25.
    - c. Smoke Developed Index: Maximum 450.
    - d. Fire Resistance Ratings: ASTM E 119.
    - e. Combustion Characteristics: ASTM E 136.
  - 2. National Fire Prevention Association (NFPA) 255 Test of Surface Burning Characteristics of Building Materials.
  - 3. Underwriter's Laboratories (UL) 723 Tests for Surface Burning Characteristics of Building Materials.
  - 4. Greenguard Children and Schools (<http://www.greenguard.org/>).
- B. Single Source Responsibility for Insulation Products: Obtain each type of building insulation from single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of work.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
  - 1. Protect against ignition at all times.

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## **PART 2 PRODUCTS**

### **2.1 GLASS FIBER BLANKET**

- A. Glass Fiber Blanket, Unfaced - ASTM C 665, Type I; with maximum flame spread and smoke developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics:
  - 1. Manufacturers are subject to compliance with requirements; provide products by one of the following:
    - a. Johns Manville (Basis of Design).
    - b. CertainTeed Corporation.
    - c. Guardian Building Products, Inc.
    - d. Owens Corning.
    - e. Approved equal.
- B. Glass Fiber Blanket, Polypropylene Scrim Kraft Faced - ASTM C 665, Type II (non-reflective faced), Class A (faced surface with a flame spread index of 25 or less); Category 1 (membrane is a vapor barrier):
  - 1. Manufacturers are subject to compliance with requirements; provide products by one of the following:
    - a. Johns Manville (Basis of Design).
    - b. CertainTeed Corporation.
    - c. Owens Corning.
    - d. Approved equal.
  - 2. Thermal Resistance: R-value of 19 in walls and 30 in roofs.

### **2.2 ACOUSTICAL INSULATION**

- A. Glass Fiber Noise Reducer Blanket, Kraft-faced - ASTM C 665, Type II; with maximum flame spread and smoke developed indexes of 25 and 50, respectively, per ASTM E 84; combustion characteristics. To be installed on interior wood stud framing:
  - 1. Manufacturers are subject to compliance with requirements; provide products by one of the following:
    - a. CertainTeed Corporation (Basis of Design).
    - b. Guardian Building Products, Inc.
    - c. Johns Manville; a Berkshire Hathaway company.
    - d. Owens Corning.
    - e. Approved equal.
  - 2. Thickness: 3 ½" at 4" nominal walls and 5 ½" thick at 6" nominal walls.

### **2.3 INSULATION FASTENERS**

- A. Adhesively Attached, Spindle Type Anchors:
  - 1. Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place:
    - a. Plate: Perforated, galvanized carbon steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square.
    - b. Spindle: Copper coated, low carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation.
- B. Adhesively Attached, Angle Shaped, and Spindle Type Anchors:
  - 1. Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place:
    - a. Angle: Formed from 0.030 inch (0.762 mm) thick, perforated, galvanized carbon

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steel sheet with each leg 2 inches (50 mm) square.

- b. Spindle: Copper coated, low carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation.
- C. Insulation Retaining Washers:
  - 1. Self-locking washers formed from 0.016 inch (0.41 mm) thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) square or in diameter:
    - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
      - 1) Crawl spaces.
      - 2) Ceiling plenums.
      - 3) Attic spaces.
- D. Insulation Standoff: Spacer fabricated from galvanized mild steel sheet for fitting over spindle of insulation anchor to maintain air space of 2 inches (50 mm) between face of insulation and substrate to which anchor is attached.
- E. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.
- F. All other materials such as wire supports, fasteners and retainers not specifically described but required to complete the work shall be as recommended by approved manufacturer, provided and installed by the Contractor.

## 2.4 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
  - 1. Glass Fiber Insulation: ASTM C 764, Type II, loose fill; with maximum flame spread and smoke developed indexes of 5, per ASTM E 84.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
- C. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide ventilation between insulated attic spaces and vented eaves.

## PART 3 EXECUTION

### 3.1 PROJECT CONDITIONS

- A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.
- B. Sequence work to ensure fireproofing and firestop materials are in place before beginning work.

### 3.2 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

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- B. Foam in Place Insulation:
  - 1. Verify that substrates are clean, dry, and free of substances that are harmful to insulation:
    - a. Priming: Prime substrates where recommended by insulation manufacturer. Apply primer to comply with insulation manufacturer's written instructions. Confine primers to areas to be insulated; do not allow spillage or migration onto adjoining surfaces.

### 3.3 INSTALLATION

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Board and Batt Insulation:
  - 1. Install insulation that is undamaged, dry, and unsoiled and has not been exposed to ice, rain, or snow at any time:
    - a. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
    - b. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.
- C. Framed Construction - Blanket Insulation:
  - 1. Install in cavities formed by framing members according to the following requirements:
    - a. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
    - b. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
    - c. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
    - d. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
    - e. For metal framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
    - f. For wood framed construction, install blankets according to ASTM C 1320 and as follows:
      - 1) With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.
    - g. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
      - 1) Glass Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).
      - 2) Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.
- D. Reflective Insulation:
  - 1. Install sheet reflective insulation according to ASTM C 727:
    - a. Install sheet radiant barriers according to ASTM C 1744.
    - b. Install interior radiation control coating system according to ASTM C 1321.



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### **3.4 PROTECTION**

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

**END OF SECTION 07 21 00**

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## **SECTION 07 25 00 WEATHER BARRIERS**

### **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 requirements including but not limited to:
  - 1. Commercial weather barrier assemblies.
  - 2. Flexible flashing.
  - 3. Weather barrier flashing.
  - 4. Fluid-applied flashing.
  - 5. Weather barrier accessories.
  - 6. Drainage material.
- B. Related Sections:
  - 1. Section 07 21 00: Thermal Insulation.
  - 2. Section 09 24 00: Cement Plastering.

### **1.3 DEFINITIONS**

- A. Weather Barrier - A combination of materials and accessories that do the following:
  - 1. Prevents the accumulation of water as a water-resistive barrier.
  - 2. Minimizes the air leakage into or out of the building envelope as a continuous air barrier.
  - 3. Provides sufficient water vapor transmission to enable drying as a vapor-permeable membrane.
- B. Water-Resistive Barrier: A combination of materials and accessories that prevent the accumulation of water within the wall assembly.
- C. Continuous Air Barrier: The combination of interconnected materials, assemblies, and sealed joints and components of the building envelope that minimize air leakage into or out of the building envelope per ASHRAE 90.1 section 5.4.3.1.
- D. Vapor Diffusion: A slow movement of individual water vapor molecules from regions of higher to lower water vapor concentration (higher to lower vapor pressure).
- E. Vapor Permeable Membrane: The property of having a water-vapor permeance rating of 10 perms (575 ng/Pa x s x sq. m) or greater, when tested in accordance with the desiccant method using Procedure A of ASTM E 96. Vapor permeable material permits the passage of moisture vapor through vapor diffusion.

### **1.4 SUBMITTALS**

- A. Product Data:
  - 1. Technical data for each type of product:
    - a. Building Wrap: Submit data on air and water-vapor permeance based on testing according to referenced standards.
- B. Shop Drawings: Show details of weather barrier at terminations, openings, and penetrations. Show details of flexible flashing applications.

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- C. Preconstruction Mockup:
  - 1. Owner will engage in a third-party testing program.
  - 2. Test Reports: Prepared by a qualified testing agency for each mockup.
  - 3. Record Drawings: As-built drawings showing changes as a result of the mock-up and illustrated in the CCD approved by DSA if applicable.
- D. Manufacturer's Instructions:
  - 1. For installation of each product specified.
- E. Sample of Manufacturer's warranty.
- F. Reports: Field test and inspection reports, as applicable.
- G. Installer's weather barrier manufacturer-training certificate.

## 1.5 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Installer: Company specializing in installing weather barriers with minimum five (5) years' experience and approved by manufacturer.
- B. Source Limitations: Provide weather barrier and accessory materials produced by single manufacturer.
- C. Preinstallation Meetings to be conducted on site.

## PART 2 PRODUCTS

### 2.1 WEATHER BARRIER

- A. Commercial Building Wrap - ASTM E 2357 passed, ABAA (Air Barrier Association of America) evaluated air barrier assembly, and assembly water resistance per ASTM E 331; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested in accordance with ASTM E 84; UV stabilized for nine-month exposure; and acceptable to authorities having jurisdiction:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide DuPont Safety & Construction: E. I. du Pont de Nemours and Company; Tyvek® CommercialWrap® or a comparable product by one of the following:
    - a. VaproShield.
    - b. Dow Chemical Company.
    - c. Raven Industries, Inc.
    - d. Approved equal.
  - 2. Performance Characteristics:
    - a. Air Permeance: Not more than 0.001 cfm/sq. ft. at 1.57 lbf/sq. ft. (0.005 L/s x sq. m at 75 Pa) when tested in accordance with ASTM E 2178.
    - b. Water Vapor Permeance: Not less than 23 perms (1300 ng/Pa x s x sq. m) per ASTM E 96/E 96M, Desiccant Method (Procedure A) or not less than 28 perms (1600 ng/Pa x s x sq. m) per ASTM E 96/E 96M, Water Method (Procedure B).
    - c. Water Penetration Resistance: Hydrostatic head resistance greater than 7.7 feet (2.35 m) in accordance with AATTC 127.
    - d. Drainability: 98 percent or greater when tested in accordance with ASTM E 2273.
    - e. Weather barrier system to have a VOC content of 30 g/L or less.

### 2.2 WEATHER BARRIER FLASHING

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- A. Conformable Weather Barrier Flashing - Composite flashing material composed of micro-creped, polyethylene laminate with a 100 percent butyl-based adhesive layer; AAMA 711 Class A (no primer), Level 3 thermal exposure, 176 deg F (80 deg C) for 7 days.
  - 1. Basis-of-Design Product - Subject to compliance with requirements, provide DuPont Safety & Construction FlexWrap™ NF or comparable product by Architect approved manufacturer.
    - a. Conformability: Able to create a seamless sill pan extending up the jambs without cuts, patches, or fasteners.
    - b. ASTM E 331 applies to water penetration testing of exterior windows, skylights, doors, and curtain walls.
    - c. Water Penetration: No leakage at 15 psf (720 Pa) per ASTM E 331.
    - d. Low Temperature Adhesion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm) at 25 degrees F (minus 4 deg C) as Class A (without primer use).
    - e. Adhesion After Water Immersion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm), after AAMA 800, Sections 2.4.1.3.1/2.4.1.4.3, Test B.
- B. Strip Flashing - Composite flashing material composed of spunbonded polyethylene laminate with 100 percent butyl-based, dual-sided, adhesive layer; AAMA 711, Class A (no primer), Level 3 thermal exposure, 176 deg F (80 deg C) for 7 days:
  - 1. Basis-of-Design Product - Subject to compliance with requirements, provide DuPont Safety & Construction StraightFlash™ VF or comparable product by Architect approved manufacturer:
    - a. ASTM E 331 applies to water penetration testing of exterior windows, skylights, doors, and curtain walls.
    - b. Water Penetration: No leakage at 15 psf (720 Pa) per ASTM E 331.
    - c. Low Temperature Adhesion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm) at 25 deg F (minus 4 deg C) as Class A without primer use.
    - d. Adhesion After Water Immersion: Exceeds minimum value of 1.5 lb./in. (0.26N/mm), after AAMA 800, Sections 2.4.1.3.1/2.4.1.4.3, Test B.

## 2.3 FLUID-APPLIED FLASHING

- A. Fluid-Applied Flashing - Trowel or brush applied, non-water soluble, single component, silyl terminated polyether technology (STPE), vapor permeable, flashing material:
  - 1. Basis-of-Design Product - Subject to compliance with requirements, provide DuPont Safety & Construction: E. I. du Pont de Nemours and Company; Tyvek® Fluid Applied Flashing & Joint Compound+ or comparable product Architect approved manufacturer:
    - a. VOC Content: ASTM C 1250, less than 2 percent by weight and between 25 to 30 g/L.
    - b. Water Vapor Transmission: ASTM E 96, Method B, greater than 20 perms (1100 ng/Pa x s x sq. m) at 25 mils (0.635 mm) thick.
    - c. Minimum Tensile Strength: ASTM D 412, 165 lb/sq. ft. (1140 kPa)
    - d. Minimum Elongation at Break: ASTM D 412; 360 percent.

## 2.4 WEATHER BARRIER ACCESSORIES

- A. Building-Wrap Tape - Pressure-sensitive plastic tape recommended by weather barrier manufacturer for sealing joints and penetrations in commercial building wrap:
  - 1. Basis-of-Design Product: DuPont Safety & Construction: E. I. du Pont de Nemours and Company; Tyvek® Tape.
- B. Fasteners with Self-Gasketing Washers - Commercial building wrap manufacturer's recommended pneumatically or hand-applied fasteners with **1-inch- (25-mm-)** diameter, high-density polyethylene cap washers with UV inhibitors:
  - 1. Basis-of-Design Product: DuPont Safety & Construction: E. I. du Pont de Nemours and Company; Tyvek® Wrap Caps.

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- C. Primer for Flashings - Synthetic rubber-based product; spray applied. Strengthen adhesive bond at low temperature applications between weather products such as self-adhered flashing products, commercial building wraps, and common building sheathing materials.
  - 1. Basis-of-Design Product: DuPont Safety & Construction: E. I. du Pont de Nemours and Company, DuPont™ Adhesive Primer.
  - 2. Peel Adhesion Test - Passes in accordance with ASTM D 3330, Test Method F, for the following:
    - a. Peel Angles: 0, 25, 72, and 180 degrees.
    - b. Substrates: Concrete masonry units (CMU), exterior gypsum sheathing, oriented strand board (OSB), aluminum, and vinyl.
  - 3. Chemical Compatibility: Pass; AAMA 713.
  - 4. Flame Spread Index: 5; ASTM E 84.
  - 5. Smoke Development Index: 0; ASTM E 84.
- D. Sealants: Provide sealants that comply with ASTM C920, elastomeric polymer sealant to maintain watertight conditions. Refer to Section 07 92 00.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, with Installer present, for compliance with requirements.
- B. Verify that substrate and surface conditions are in accordance with commercial weather barrier manufacturer recommendations prior to installation:
  - 1. Verify that rough sill framing for doors and windows is sloped downwards towards the exterior and is level across width of the opening.
- C. Verify that surfaces to receive weather barrier flashing are clean, dry, and free of frost.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Direct water onto an acceptable weather barrier drainage plane with an unobstructed path to exterior of wall:
  - 1. Provide a drainage path for water intrusion through window and door attachment system that collects at window and door sills and directs water to the exterior or weather barrier.

### **3.3 COMMERCIAL BUILDING WRAP INSTALLATION**

- A. General: Comply with weather barrier manufacturer's written instructions and warranty requirements.
- B. Cover exposed exterior surface of sheathing with weather barrier securely fastened to framing immediately after sheathing is installed:
  - 1. Maintain continuity of air and water barrier assemblies.
  - 2. Start weather barrier installation at a building corner, leaving 12 inches (300 mm) of weather barrier extended beyond corner to overlap.
  - 3. Install weather barrier horizontally starting at lower portion of wall surface.
  - 4. Provide minimum 6 inches (150 mm) overlap at horizontal- and vertical-wrap seams in a shingle manner to maintain continuous downward drainage plane and air and water barrier.

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- C. Seams:
  - 1. Seal seams with building wrap tape per manufacturer's recommended installation instructions:
    - a. Shiplap horizontal seams in weather barrier to facilitate proper drainage.
- D. Fasteners:
  - 1. Use weather barrier manufacturer's recommended fasteners to secure weather barrier and install fasteners according weather barrier manufacturer's installation guidelines:
    - a. Do not use temporary fasteners to permanently attach weather barrier.
    - b. Do not place fasteners with gasketing washers where weather barrier flashing will be installed.
    - c. Install fasteners with gasketing washers through flashing where recommended by manufacturer.
- E. Openings:
  - 1. Completely cover openings with weather barrier, then cut weather barrier membrane to openings according to weather barrier manufacturer's installation guidelines:
    - a. Provide head and jamb flaps and seam overlaps to maintain continuous drainage.
    - b. Repair damage to weather barrier using method recommended by weather barrier manufacturer.
    - c. Install flashing according to weather barrier manufacturer's installation guidelines.

### 3.4 WEATHER BARRIER FLASHING INSTALLATION

- A. Installation:
  - 1. Remove wrinkles and bubbles, reposition weather barrier as necessary to produce a uniform, smooth surface:
    - a. Ensure that ambient and substrate surface temperatures are acceptable in accordance with manufacturer instructions and recommendations.
    - b. Wipe surfaces to remove moisture, dirt, grease and other debris that could interfere with adhesion.
    - c. Apply weather barrier manufacturer's recommended primer over concrete, masonry, and glass-mat gypsum wall sheathing substrates to receive weather barrier flashing.
    - d. Lap weather barrier flashing a minimum of 2 inches (50 mm) onto weather barrier.
    - e. Apply pressure over entire surface using roller or firm hand pressure
- B. Rough Openings:
  - 1. Shiplap flashing with weather barrier in a shingle manner to maintain a continuous downward drainage plane and air and water barrier in accordance with manufacturer's written instructions:
    - a. Retain first option below for stud framing that is nominally 4 inches (100 mm) thick. Retain second option for stud framing that is nominally 6 inches (150 mm) thick.
    - b. Apply 9-inch- (230-mm-) (for stud framing that is nominally 6 inches thick) wide conformable weather barrier flashing at door and window sills.
    - c. Ensure that sill flashing does not slope to the interior.
    - d. Install backer rod in joint between frame of opening product and flashed rough opening on the interior.
    - e. Apply sealant or closed-cell polyurethane foam insulation around entire opening/fenestration product to create air seal around interior perimeter of window openings in accordance with weather barrier manufacturer's instructions.
    - f. Weather barrier flashing selection and application methods are specific to type of opening product and rough opening configuration. When building envelope design requirements exceed ASTM E 1677, 65 mph equivalent structural load, and 15 mph equivalent wind-driven rainwater infiltration resistance, use butyl-based DuPont™ "StraightFlash™" and wrap cap screws in subparagraphs below.

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- g. Around door and window openings, apply butyl-based flashing to flaps of weather barrier.
  - h. Use strip flashing with wrap cap screws to secure head flap of the windows.
- C. Penetrations:
  - 1. Apply weather barrier manufacturer's recommended weather barrier flashing patches behind fastening plates, such as brick-tie base plates, metal-flashing clips, and metal channels:
    - a. Seal weather barrier around each penetration with weather barrier manufacturer's recommended self-adhered flashing product or sealant. Integrate products with flanges into the weather barrier.
- D. Terminations:
  - 1. Provide minimum 2 inches (50 mm) overlap using strip flashing on adjoining roof and base of wall systems to maintain continuous downward drainage plane:
    - a. Secure weather barrier with fasteners and weather-barrier flashing.

### 3.5

### 3.6 DRAINAGE MATERIAL INSTALLATION

- A. Install drainage material with grooves or channels running vertically in compliance with manufacturer's written instructions.

### 3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to train installers and observe subject test-wall areas and installations.
- B. Prepare test and inspection reports.

### 3.8 CLEANING

- A. Immediately remove release paper and scrap from work area and dispose of material in accordance with requirements of Section 01 73 00: Execution and Section 01 74 19: Construction Waste Management and Disposal.

### 3.9 PROTECTION

- A. Protect installed weather barrier from the following:
  - 1. Damage from cladding, structure, or a component of the structure (e.g., window, door, or wall system).
  - 2. Contamination from building site chemicals, premature deterioration of building materials, or nonstandard use or application of products.
  - 3. Foreign objects or agents, including the use of materials incompatible with weather barrier products.
  - 4. UV exposure in excess of products' stated limits.

**END OF SECTION 07 25 00**

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## **SECTION 07 32 13 CLAY ROOF TILES**

### **PART 1 GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- A. Drawings and Conditions of Contract, including General and Supplementary Conditions and Division 1 Administration Sections, apply to this Division.

#### **1.2 SUMMARY**

- A. This section includes the following:
  - 1. Clay Tile (Architectural Terra Cotta). Remove, install battens ridge, underlayment and flashing and install existing Clay tile roof.
  - 2. Underlayment for Clay Tile.
  - 3. Flashing for Clay Tile.
- B. Related Sections include:
  - 1. Section 06 10 00: Rough Carpentry
  - 2. Section 07 62 00: Roof Related Sheet Metal.

#### **1.3 REFERENCES**

- A. Reference Standards:
  - 1. ASCE 7: Minimum Design Loads for Buildings and Other Structures.
  - 2. ASTM A653: Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process.
  - 3. ASTM A792: Steel Sheet, 55 % Aluminum Zinc Alloy Coated by the Hot Dip Process.
  - 4. ASTM C1371: Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
  - 5. ASTM C1549: Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
  - 6. ASTM E1592: Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
  - 7. ASTM C-1167 Tile installation.
  - 8. SMACNA Architectural Sheet Metal Manual.

#### **1.4 SUBMITTALS**

- A. Product Data.
- B. Shop Drawings:
  - 1. Indicate thickness and dimensions of parts, fastenings and anchoring methods as indicated on drawings, details and locations of joints, transitions and other provisions necessary for thermal expansion and contraction. Indicate replacement of existing tiles and match existing attachments.
  - 2. Indicate eave starter tiles.
  - 3. Indicate locations of field and factory-applied sealant.
  - 4. Indicate location of wood blocking, cant strips and their attachments.
  - 5. Vertical wall flashing, ridge flashing and sill flashing.
- C. Samples:
  - 1. Submit two samples, 12 inches long by full panel width, showing proposed metal thickness and seam profile.



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2. Submit standard color samples of metal for Architect's selection.
- D. Manufacturer Qualifications.
- E. Installer Qualifications: Submit list of completed projects, with names and contact information for architects and contractors.
- F. Test Reports: Indicating compliance of products with project requirements.
- G. Warranty Documentation.
- H. Insurance Documentation.

## **1.5 QUALITY ASSURANCE**

- A. Manufacturer Qualifications:
  1. Ten years' experience, minimum, in factory fabrication of tile products.
- B. Installer Qualifications:
  1. Three years' experience, minimum, in application of tile roof installations.
  2. Five satisfactory projects with metal panel work of similar scope and complexity to Work of this Project.
- C. Mock-Ups:
  1. Visual Mock-Up: Construct mock-up, as required to show at least two pattern repeats, and in same orientation designated by Architect.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Storage and Handling Requirements:
  1. Keep tiles and accessory items dry.
  2. Protect against damage and discoloration.
  3. Handle tiles with non-marring slings.
  4. Support tiles to prevent permanent deformation.
  5. Store tiles above ground, with one end elevated for drainage.
  6. Protect panels against standing water and condensation between adjacent surfaces.
  7. If panels become wet, immediately separate sheets, wipe dry with clean cloth, and keep sheets separate for air-drying.
  8. Painted panels shall be shipped with protective plastic sheeting or a strippable film coating between panels. Remove strippable film coating prior to installation. Do not allow strippable film coating to remain on panels in extreme heat, cold, or direct sunlight or other UV source.

## **1.7 WARRANTY**

- A. Special Clay Roof Tile Manufacturer's Warranty:
  1. Manufacturer's standard form in which manufacturer agrees to repair or replace new tile that fails in materials within specified warranty period. Material failures include manufacturing defects that result in leaks:
    - a. Material Warranty Period: 50 years.
- B. Special Roofing Installer's Warranty:
  1. Roofing Installer's warranty, on warranty form at end of this Section, signed by roofing Installer, covering Work of this Section, in which roofing Installer agrees to repair or replace components of concrete tile roofing that fail in materials or workmanship within

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the following warranty period:

- a. Warranty Period: 2 years.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Clay Tiles:
  1. Subject to compliance with requirements, provide products by one of the following manufacturers. Clay Tiles are intended to match current existing tiles listed as basis of design:
    - a. Boral, 1-piece "S" tile (Basis of Design).

### **2.2 CLAY TILES**

- A. Product:
  1. Clay Roof Tile with Caps as manufactured by Boral, or equal:
    - a. Profile: 1-piece "S" tile:
      - 1) Color: Match existing. Old World 2.
    - b. Caps and covers:
      - 2) Color: Match existing. Old World 2.
- B. Clay Tile - ASTM C1167:
  1. Molded or extruded clay roof tile units of shape and configuration to match existing, kiln fired to vitrification, and free of surface imperfections. Provide with fastening hoes pre-punched at factory before firing. The acceptable clay roof tile shall be:
    - a. Durability: Grade 1.
    - b. Size: 18" x 13" to match existing
    - c. Weight: Standard weight tile
- C. Clay tile Accessories: Provide special shapes to suit valley, ridge, rake, eave, and other conditions noted on drawings.
- D. Install system in accordance with local jurisdiction and codes, with manufacturer's guidelines, and with ICC ES ESR-2015 "Concrete and Clay Roof Tile Installation Manual for Moderate Climate Regions" (July 2015).
- E. Roof Classifications Approvals: Class A roof tiles installed in accordance with CBC Section 1504.2.

### **2.3 BITUMINOUS MATERIALS**

- A. SBS Modified Bitumen Underlayment: A special elastomeric modified bitumen blend of SBS and other polymers applied onto an internal reinforcing mat, Lastobond Shield HT, 64 mil thick, as manufactured by Soprema, or equal.
- B. Roof Cement - ASTM D 4586-86, Type II (to seal corners of membrane and top edges of pipe flashings). Mastic shall be approved by the SBS modified bitumen manufacturer.

### **2.4 CEMENT (Weather block on all hips, ridges and transitions)**

- A. Portland Cement - ASTM C-150, Type II:
  1. Aggregate: ASTM C144.
  2. Water: Clean, potable.
  3. Proportions: UBC Table No. 24-A, Type O.

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4. Strength: 1500-2500 psi.
5. Color: Color to be approved by Architect.

## **2.5 UV-RESISTANT PRESSURE SENSITIVE MEMBRANE TAPE WEATHER-BLOCKING**

- A. UV-Resistant; exposable to UV.
- B. Peel and Stick, Self-Adhered, Pressure Sensitive.
- C. Seals to contours of tile roofing, Moldable, Conformable for full adhesion across variable contours.
- D. Adhesive:
  1. SBS-Modified, rubberized asphalt adhesive.
  2. Butyl.
- E. All-weather.
- F. Internal malleable aluminum.
- G. Meets Tile Roofing Institute Technical Brief #01-701, "Weather Blocking of Hips, Ridges, and Headwalls."
- H. Basis of Design:
  1. Tile Flash 60XL by ProtectoWrap:
    - a. 12-inch width.
  2. Architect Approved Equal.

## **2.6 ROOF ADHESIVE**

- A. Basis of Design:
  1. Tile Bond Roof Tile Adhesive by Dupont.
  2. One-Component Polyurethane Foam.

## **2.7 ROOF SEALANT/ADHESIVE**

- A. Basis of Design:
  1. Rainbuster 850:
    - a. One-component polyurethane sealant/adhesive.
    - b. Color to match tile.
    - c. Non-shrinking, non-sag.
    - d. Permanent flexibility.

## **2.8 FASTENERS**

- A. All fasteners and metal components shall be corrosion resistant.
- B. Ring Shank nails in lieu of smooth box nails.
- C. Smooth, common or box, electro-galvanized nails will not be accepted.
- D. Connectors shall be Stainless Steel for Variable Head Lap (i.e. head lap may be any depth, 3-inches, 4-inches or other).
- E. Twisted Wire Tie System: Use the Twisted Wire Tye -Tye System as manufactured by

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Newport Tool & Fastener Company, Inc., Orange, California. The Twisted Wire is to be –13 gauge (.090 inch diameter) Type 304 stainless steel conforming to ASTM A580.

- F. Individual roof tiles are tied into the Twisted Wire Tyle-Type by means of a tie wire. Use 16 gauge (.0625 inch diameter) stainless steel tie wires (18 inch or 28 inch) with stainless steel Tyle Tie systems.
- G. For insulated steel decks use the double plate anchor system encompassing two 3 inch diameter stainless steel stamped plates and stainless steel deck screws of appropriate length.
- H. Hurricane clip for first course of tile shall be 16 gauge by 1/2 inch.
- I. Nose clip or wind locks for hip and ridge trim tiles shall be 12 gauge galvanized steel.
- J. Fasteners for Sheet Metal to Wood:
  - 1. Concealed Application: Annular threaded nail with minimum 3/8 inch diameter head of sufficient length to penetrate minimum 3/4 inch into substrate.
  - 2. Exposed Application: Screws shall be No. 8 minimum, shall penetrate wood blocking minimum 1-1/2 inch and shall have watertight steel/neoprene washers under head. The installed withdrawal resistance shall be a minimum of 150 pounds per screw.
- K. Fasteners for Tile under Roof-To-Wall: Batten strips are to be 1 inch x 2 inch lumber stringers. Maximum length 4 feet. Fasteners to be screws. 5-each screws per 4-foot stick.
- L. Fasteners for securing 2x Stringers:
  - 1. Install with TA Staircase Angle or ML Angle, by Simpson Strong Tie.
  - 2. 2x Stringer installed parallel with slope of roof to support the cap tile.
  - 3. 12 gauge.
  - 4. Stainless Steel.
  - 5. Encapsulate with weather blocking as required by Code.
  - 6. Connectors shall be encapsulated with weather blocking.

## 2.9 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet:
  - 1. 30 to 40 mils thick minimum, consisting of slip-resisting, polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer:
    - a. Thermal Stability: Stable after testing at 240 deg F; ASTM D 1970.
    - b. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.
    - c. Location: At eaves, rakes, valleys, penetrations, slope and direction changes, horizontal and soffit areas, in addition to where indicated on Drawings.
    - d. Method: Overlap with felt after putting down Self-Adhering sheet.
    - e. Products are subject to compliance with requirements; provide either the named product or an equal product by one of the other manufacturers specified:
      - 1) Soprema, Lastobond Shield HT (Basis of Design).
      - 2) GCP Applied Technologies.
      - 3) Carlisle Coatings & Waterproofing.
      - 4) Architect approved equal.
- B. Polymeric Slip Sheet:
  - 1. Basis of Design:

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- a. Tiger Paw by GAF.
2. UV-Stabilized Polypropylene.

## **2.10 SHEET METAL FLASHING AND TRIM**

- A. Sheet Metal Flashing and Trim:
  1. Comply with requirements in Division 07.
  2. Sheet Metal: Galvanized steel.
  3. Coping: Aluminum brake metal with fluorocarbon finish
- B. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item.

## **PART 3 EXECUTION**

### **3.1 TILE ROOFING RETROFIT AND REPAIR SCOPE OF WORK**

- A. Remove and stage/store existing tile at rooftop locations. Do not overload roof.
- B. Any cracked, broken, or otherwise damaged tile shall be removed and properly disposed of.
- C. Remove existing underlayment, stringers, nailers, flashings, and perimeter details.
- D. Clean and inspect existing roof substrate.
- E. Replace any damaged substrate per local jurisdiction, School District, and PBK.
- F. Prepare substrate for new underlayment:
  1. Seal Sidewall details.
  2. Seal Headwall detail.
  3. Seal pitch break details.
  4. Complete details per TRI Installation Guide & ICC ES ESR-2015.
  5. Install Lastobond Shield HT Underlayment by Soprema. Lay flat with no wrinkles. Lay plumb with eaves.
- G. Install new polymeric slip sheet over the peel-&-stick membrane – Tiger Paw premium, UV-Stabilized Polypropylene Underlayment by GAF.
- H. Properly tie-in to existing flat roofs at gutter.
- I. Install perimeter details to meet Code and match current appearance.
- J. Headwall:
  1. Use existing sheet metal headwall flashing.
  2. Secure loose tile.
  3. Ensure weatherproof installation.
  4. Install UV-Resistant Weather blocking over sealed assembly:
    - a. Protecto Wrap Tile Flash 60XL.
    - b. Trimline VariaBlock – Color to match roofing.
    - c. Trimline VariaFlash – Color to match roofing.
  5. Use Type 100 sealant to seal stucco-sheet metal confluence.
  6. Under no circumstance shall any woodwork be exposed. Encapsulate and properly shingle underlayments, weather blocking, and sheet metal flashings.

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- K. Gable Rake:
  - 1. Install new 2x nailer.
  - 2. Wrap new roofing system down roof edge a minimum 2-inches. Secure with termination bar, sealed with butyl tape and caulking bead, secured 6-inches on center.
  - 3. Install tile trim according to Code for high-wind installations.
- L. Secure any loose tile.
- M. Properly tie-in to existing flat roof, walls, and sheet metal flashings.
- N. Re-install tile replacing any damaged tile. Install tile to meet current Code (i.e. local jurisdiction and ESR-2015). Tile shall be installed to meet High-wind requirements. Fasteners to be ring shank nails or screws.
- O. Install tile in same locations from which they were removed to eliminate any visible "tan lines" or "fade lines."
- P. Dust, debris, and any foreign matter shall be removed from the interlock locations between tiles.
- Q. New tile to be installed in their own courses.

### **3.2 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
- B. Verify that surfaces and site conditions are ready to receive work.
- C. Verify all decks are in suitable condition or identify corrective work that is needed.
- D. Verify that surfaces to receive roofing are smooth, sound, clean and dry.
- E. Verify roof openings, curbs, pipes, conduit, sleeves, ducts, and vents through roof are solidly set, correct as required.
- F. Examine roof deck for conditions that would prevent proper application of roofing. Immediately notify School District, Custodial Staff, and PBK of defects, and do not proceed with roofing operation until defects are corrected.

### **3.3 PREPARATION AND CLEANING**

- A. Trim trees back from roof. Coordinate with School District Custodial Staff and PBK. Trees shall not present a danger or hazard for or to roofing operations.
- B. Staging must be coordinated with the custodial staff so as to have minimum impact on the ongoing operations of the facility.
- C. Keep facility watertight during the project.

### **3.4 GENERAL CONDITIONS**

- A. Verify conditions are acceptable for application / installation prior to beginning work. Verify surfaces are uniform, smooth, dry, and clean. Beginning work constitutes acceptance of the

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conditions as satisfactory by the roofing contractor.

- B. The contractor will have sufficient materials properly packaged and protected on the site prior to beginning work to ensure continuity of work without interruption due to lack of materials or equipment. The contractor has sole responsibility for protecting the materials and equipment brought onto the site by the contractor.
- C. The contractor will have sufficient quantity of properly trained technicians on site during installation once work has begun to allow the project to proceed at a reasonable and proper pace and to ensure the quality of installation.
- D. Store rolled goods, buckets, sealants, adhesives, pallets, and tile in their packaging in a dry, protected area at a temperature not exceeding 110° F
- E. Install system in accordance with local jurisdiction and codes, with manufacturer's guidelines, and with ICC ES ESR-2015 "Concrete and Clay Roof Tile Installation Manual for Moderate Climate Regions" (July 2015).
- F. Follow guidelines and provisions for high wind installation:
  - 1. 2x Stringer installed parallel with slope of roof to support the cap tile:
    - a. 12 gauge.
    - b. Stainless Steel.
    - c. Encapsulate with weather blocking as required by Code.
    - d. Connectors shall be encapsulated with weather blocking.
  - 2. Ring Shank nails in lieu of smooth box nails.
  - 3. 2x Stringers to be wrapped in weather blocking.
  - 4. Smooth, common or box, electro-galvanized nails will not be accepted.
  - 5. Connectors shall be Stainless Steel for Variable Head Lap (i.e. head lap may be any depth, 3-inches, 4-inches or other).
  - 6. One nail per tile - each tile or piece of installed tile shall be secured.
  - 7. Cut tile shall be secured with adhesive/sealant specified herein (Tile Bond Adhesive, Rainbuster 850). Follow guidelines in Tables 1A and 1B in ICC ES ESR-2015 "Concrete and Clay Roof Tile Installation Manual for Moderate Climate Regions" (July 2015).
  - 8. Noses of all tile shall be secured with a storm clip, wind clip, Hurricane Clip, Nose Hook, or Tile Bond Adhesive.
  - 9. Noses of all eave course tile shall be secured with a wind clip or hurricane clip.
  - 10. All rake tile shall be secured with two fasteners and adhesive.
  - 11. Noses of all hip, ridge, and rake tiles shall be set in a bead of adhesive as specified herein (Tile Bond Adhesive, Rainbuster 850).
- G. Coordinate installing the roofing system so none of the substrate and components of the new roof system to be installed are subjected to precipitation at any time or are left uncovered at the end of the workday or when rain is forecast. Temporary terminations will be used at the end of every work day. All temporary terminations will be removed prior installation of the permanent detail.
- H. Take whatever precautions are necessary to ensure that the installed system is both clean and free of contaminants. Upon completion the surface of the roof system must be clean and free of unnecessary marks.
- I. Keep all foot traffic to an absolute minimum where the underlayments have been installed and the roof system has been installed.
- J. Take all reasonable precautions to have minimal impact on the on-going operations of the

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facility during the entire length of the project.

- K. Do not drop rolled, bucket, or bundled goods onto the roof deck.
- L. Workmanship:
  - 1. Flashings: Form to shapes and dimensions according to insitu construction conditions. Form shapes free from defects which impair strength or mar appearance.
  - 2. Form planes and lines to true alignment.
  - 3. Install roofing using skilled workman, in strict accordance with manufacturers' recommendations, guidelines, and approved shop drawings. Details shown on drawings shall be considered typical and apply for similar features where not particularly detailed.

### **3.5 DEMOLITION, PREPARATION, AND CLEANING**

- A. Remove sealants. Clean substrate for application of new sealant.
- B. Remove any trash, vegetation, and debris from roof, drains, scuppers, leader heads, water ways, etc.
- C. Remove tile and trim in a methodical and calculated fashion beginning from the highest point and working downslope. Minimize damage and breakage.
- D. Any cracked, broken, or otherwise damaged tile shall be removed and properly disposed of.
- E. Remove and replace cracked, broken, or otherwise damaged tile.
- F. Store undamaged tile so that it may be re-installed in its original position. In this way, a "tan line" or "fade line" will not be visible.
- G. Do not overload roof.
- H. Store undamaged tile so that it may be used for later use.
- I. Remove all underlayments, felts, and slip sheets.
- J. Remove all stringers, nailers, flashings, weather blocking, and perimeter details as noted on drawings.
- K. Remove all sheet metal flashing unless noted to remain on drawings
- L. Legally dispose of all garbage, rubbish, and construction debris including damaged tile.
- M. Inspect substrate for damage and defects. Replace damaged sheathing. Prepare substrate for new self-adhering underlayment.
- N. Repair any damaged substrate and framing per local jurisdiction, School District, and PBK.
- O. Remove and legally dispose of sheet metal terminations, accessories, and fixtures, internal gutters, and downspouts.
- P. Prevent materials from entering and clogging roof drains with drain plugs, and conductors, and from spilling or migrating onto surfaces of other construction, or from entering the building interior.



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- Q. Clean the existing roof surface or substrate of dust, debris, moisture and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections. Use blower or pressurized air.
- R. Repair any aspect of the construction that may be detrimental to the Work.

### **3.6 SEALANTS**

- A. Remove existing sealants at terminations & sheet metal fixtures.
- B. Provide proper and clean substrate for application of new sealants.
- C. Install new urethane sealant at sheet metal fixtures and trim ensuring full engagement of sealant.
- D. Sealant color shall match roofing color.

### **3.7 PENETRATIONS**

- A. At improper pipe flashings, prepare pipe for new pipe flashing. Install new pipe flashings with sealants and bands.
- B. Install base flashing (sub-flashing) integral with new underlayments.
- C. Extend pipe to a minimum 10-inches above finished roof surface.
- D. Provide proper roof and wall penetrations. Penetrations shall be sealed.
- E. Provide proper penetration flashings secured and sealed into roof system.

### **3.8 UNDERLAYMENT INSTALLATION – SELF-ADHERING UNDERLAYMENT**

- A. Follow Installation Guidelines for Winterguard HT or Lastobond Shield HT (Basis of Design for Self-Adhering Underlayment).
- B. Provide proper and clean substrate for application of new membranes.
- C. Install a single layer of Winterguard HT or Lastobond Shield HT at details including but not limited to the vent penetrations, pipe penetrations, hips, headwalls, eaves, sidewalls, rakes, etc.
- D. Install a single layer at details including but not limited to the hips, headwalls, eaves.
- E. Fully-adhere single layer horizontally starting at the bottom of the sloped roof in the gutter. Provide 4-inch side lap and 6-inch end laps. Shingle laps.
- F. Seal details.
- G. Install single layer at headwall ensuring the membrane extends up the wall a minimum 3-inches.
- H. Extend an 18-inch strip centered at the hip extending the entire length of the hip.
- I. Shingle membrane with new Modified Bitumen Roofing System at bottom of slope in the gutter.

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- J. Tie into headwall/hip/top-of-wall underlayment using proper shingle methods.

### 3.9 ROOF TILE INSTALLATION

- A. Follow system manufacturer's guidelines for proper installation i.e. ICC ES ESR-2015 "Concrete and Clay Roof Tile Installation Manual for Moderate Climate Regions" (July 2015). Failure to properly follow the manufacturer's requirements and recommendations with regards to the installation of the underlayment, vents, or the tile asphalt shingles will be cause for the contractor having to remove and replace the defective areas at the sole expense of the contractor, in addition to extra inspections being scheduled.
- B. Follow manufacturer recommendations and requirements for proper installation of EVERY component of the new system, including but not limited to, the mechanically fastened underlayment, the self-adhered membrane, and the tile roofing. Always install every component to the higher standard without exception.
- C. Nailers and stringers shall be wrapped with Code Compliant, UV-Resistant weather blocking membrane.
- D. Woodwork shall not be "toe nailed." 12 gauge brackets and connectors shall be used to secure nailers and stringers.
- E. Install weather blocking by MFM (Ridge Seal Plus) or So-Lite or mortar at hips, ridges, and headwalls ensuring no gaps in the detail.
- F. Form the weather blocking to the contour of the hip and headwall detail.
- G. If mortar is used, woodwork must be wrapped with underlayment to prevent mortar contact with wood components.
- H. Secondary UV-resistant weather blocking shall be installed at cap stringers to keep water on surface of tile and not beneath tile.
- I. Mortar shall not be in contact with woodwork.
- J. Weather blocking shall be installed to keep water on the surface of the tile.
- K. Under no circumstance shall any woodwork be exposed. Encapsulate and properly shingle underlayments, weather blocking, and sheet metal flashings.
- L. The same standard applies to the gutters, downspouts, and flashings.
- M. Exercise care to keep existing flashings sound and intact.
- N. Keep the surface clean and free from marks.
- O. Install eave and rake drip edge flashings integral with underlayment. Secure sheet metal 3-inches on center staggered. Shingle felt over drip edge.
- P. Layout and align roofing in exact locations from which they were removed to avoid "Tan Lines" or "Fade Lines."
- Q. Install eave riser and birdstop at eaves. Eave tile shall be secured with 1-each ring shank nail and 1 each wind clip. Install new birdstop per Detail MC-10C of ESR-2015.

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- R. Headlap shall be minimum 3-inches.
- S. Install in accordance with high-wind requirements:
  - 1. 2x Stringer installed parallel with slope of roof to support the cap tile:
    - a. Install with TA Staircase Angle or ML Angle, by Simpson Strong Tie.
    - b. 12 gauge.
    - c. Stainless Steel.
    - d. Encapsulate with weather blocking as required by Code.
    - e. Connectors shall be encapsulated with weather blocking.
  - 2. Smooth, common or box, electro-galvanized nails will not be accepted.
  - 3. One nail per tile: Each tile or piece of installed tile shall be secured.
  - 4. Cut tile shall be secured with adhesive/sealant specified herein (Rainbuster 850 or Tile Bond). Follow guidelines in Tables 1A and 1B in ICC ES ESR-2015 "Concrete and Clay Roof Tile Installation Manual for Moderate Climate Regions" (July 2015).
  - 5. Noses of all eave course tile shall be secured with a storm clip.
  - 6. All rake tile shall be secured with two fasteners and adhesive.
  - 7. Noses of all cap, hip, ridge, and rake tiles shall be set in a bead of adhesive as specified herein (Rainbuster 850 or Tile Bond).
- T. Install hip stringer at hips. Install field tile and cut tile adjacent to hip stringer.
- U. Install weather blocking membrane at cap stringers ensuring no gaps in the weather blocking. Form the weather blocking to the contour of adjacent details. Encapsulate brackets and connectors. Weather blocking at cap stringers shall be fully water-resistant.
- V. Install weather blocking by MFM (Ridge Seal Plus) or So-Lite or mortar at hips, ridges, and headwalls ensuring no gaps in the detail. Form the weather blocking to the contour of the hip and headwall detail.
- W. If mortar is used, woodwork must be wrapped with underlayment to prevent mortar contact with wood components.
- X. Reinstall trim tile according to ICC ES ESR-2015 "Concrete and Clay Roof Tile Installation Manual for Moderate Climate Regions" (July 2015).
- Y. Retrofit valleys. Install Winterguard HT or Lastobond Shield HT beneath valley metal centered in valley pitch break, and provide an overlapping valley construction. Cut tile along pitch break for proper closed construction.
- Z. Reuse tile from one face and move to other faces. Lowest courses of tile can be replaced with new modern concrete tile that can interlock as required.
- AA. Reuse tile shall be moved to the front of the school, while new tile shall be installed in the rear of the school.
- BB. Tile adhesive to be Tile Bond by Dow Chemical.
- CC. Roof adhesive/sealant to be polyurethane sealant/adhesive by Rainbuster (Rainbuster 850, color to match roofing). Asphaltic mastic will not be permitted.
- DD. Dust, debris, and any foreign matter shall be removed from the interlock locations between tiles.
- EE. New tile to be installed in their own courses.

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### 3.10 ROOF DETAILS

- A. Install perimeter details to meet Code and match current appearance.
- B. Nailers and stringers shall be wrapped with Code Compliant weather blocking membrane.
- C. Mortar shall not be in contact with woodwork.
- D. Woodwork shall not be "toe nailed." Brackets and connectors shall be used to secure nailers and stringers.
- E. Weather blocking shall be installed to keep water on the surface of the tile.
- F. Hip and Peak Trim:
  - 1. Stringers shall be wrapped with weather blocking membrane.
  - 2. Install hip stringer with 12 gauge brackets or connectors.
  - 3. Fully encapsulate stringers and connectors with weather blocking membrane.
  - 4. Weather blocking shall be fully waterproof.
  - 5. Secondary weather blocking shall be installed so that water remains on surface of tile and not beneath it.
  - 6. Replace any damaged tile.
  - 7. Secure with new Ring Shank nails and adhesive.
  - 8. Adhere tile at detail locations to minimize chatter and wind effects.
- G. Headwall:
  - 1. Use existing sheet metal headwall flashing.
  - 2. Exercise care to keep existing flashings sound and intact.
  - 3. Secure loose tile.
  - 4. Ensure weatherproof installation.
  - 5. Install weather blocking over sealed assembly.
  - 6. Weather blocking shall be fully waterproof.
  - 7. Secondary weather blocking shall be installed so that water remains on surface of tile and not beneath it.
  - 8. Replace any damaged tile.
  - 9. Use Type 100 sealant to seal stucco-sheet metal confluence.
  - 10. Under no circumstance shall any woodwork be exposed. Encapsulate and properly shingle underlayments, weather blocking, and sheet metal flashings.
  - 11. Retrofit valleys. Install Winterguard HT or Lastobond Shield HT beneath valley metal centered in valley pitch break, and provide an overlapping valley construction. Cut tile along pitch break for proper closed construction.
- H. Closed Valley:
  - 1. Install Winterguard HT or Lastobond Shield HT centered in valley pitch break and extending the length of the valley.
  - 2. Provide an overlapping underlayment valley construction.
  - 3. Provide Triple Crown W-Valley with Splash Hems (W-W Valley Metal with splash hems) across pitch break. Secure top of valley metal with 2-each nails in pan of valley metal (These nails shall be shingled by overlying sheet metal). Secure with nails bent over hem or use 2-inch wide metal clips, spaced 24-inches on center beginning 4-inches from lowest edge of valley metal. Seal nails and clips with Rainbuster 850.
  - 4. Cut tile along pitch break for proper closed construction.
  - 5. Secure any loose tile.
- I. Gable Rake:
  - 1. All rake tile shall be secured with two fasteners and adhesive.

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2. Install new 2x Nailer and Booster. Secure with 12 gauge bracket or connector, 12-inches on center. Connectors shall be sealed or otherwise encapsulated with weather blocking.
  3. Wrap nailers and boosters in weather blocking membrane.
  4. Extend underlayment over roof edge a minimum 2-inches.
  5. Wrap new roofing system down roof edge a minimum 2-inches. Secure with termination bar.
  6. Termination bar to be sealed with butyl tape and a bead of polyurethane sealant. Secure 6-inches on center.
  7. Install tile trim according to Code with 2-each corrosion-resistant, ring shank nails per trim tile.
  8. Seal/adhere trim tile at butt end over nail.
- J. Eaves:
1. Install eave riser and birdstop at eaves.
  2. Eave tile shall be secured with 1-each ring shank nail and 1 each wind clip. Install new birdstop per Detail MC-10C of ESR-2015.
  3. Noses of all eave course tile shall be secured with a storm clip, including the Cap Tile.
  4. Pan tile shall have 2-each fasteners at eave tile.
- K. Penetrations/Protrusions:
1. Provide deck flashing integral with underlayment. Fasteners shall be encapsulated or otherwise shingled by the underlayment.
  2. Provide tile flashings that shall conform to the contours of the tile system.
  3. Tile Flashings shall extend onto the tile a minimum of 4-inches and a minimum 1-inch past the crown of a cap tile.
  4. For contoured tile / profiled tile, a moldable flashing shall be used.
  5. Provide storm collar or umbrella flashings at all penetrations.
- L. Secure any loose tile.
- M. Properly tie-in to existing flat roof in gutters. Tie underlayment into the new roofing at the gutters in a warrantable fashion.
- N. Termination of tile roofing (at its eave in the gutter) shall be at a level plane of the overflow drains in gutters.
- O. Properly tie-in to any walls and sheet metal flashings.

### 3.11 ROOF DEFICIENCIES & DEFECTS

- A. Repair chips using tile adhesive. Repair per Tile Roofing Institute & Western States Roofing Contractors Association (i.e. ICC ES ESR-2015).
- B. Replace broken or damaged tile per ESR-2015.
- C. Remove and replace cracked or damaged tile.
- D. Secure loose tile.
- E. New tile to be installed in their own courses. Do not use secondary tile at interlocks with existing Tile.

### 3.12 CLEANING

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- A. All new roof surfaces will be left clean and free of debris upon completion of the project.

### **3.13 PROTECTION**

- A. Take all measures necessary to protect building surfaces against damage from roofing work.
- B. Where traffic must continue over finished tile roof, protect surfaces. Consider removing tile until Work is complete in that location. Re-install tile.

**END OF SECTION 07 32 13**

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## **SECTION 07 62 00 ROOF RELATED SHEET METAL**

### **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. It is the intent of this Section that the Work shall:
  - 1. Conform to all applicable DSA and building code requirements.
  - 2. Include all shop and field formed sheet metal work shown on drawings, specified or required, including, but not limited to:
    - a. Roof penetration sleeves, collars, hood, and umbrella counterflashing.
    - b. Metal counterflashing.
    - c. Expansion joint.
- B. Related Sections:
  - 1. Section 05 50 00: Metal Fabrications.
  - 2. Section 07 13 26: Self-Adhering Sheet Waterproofing
  - 3. Section 07 25 00: Weather Barriers.
  - 4. Section 07 92 00: Joint Sealants.
  - 5. Division 22 Plumbing.
  - 6. Division 23 Mechanical.
- C. Reference Standards:
  - 1. ASTM International (ASTM):
    - a. A525, Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
    - b. A526, Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.
    - c. A527, Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality.
    - d. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
    - e. B32, Standard Specification for Solder Metal.
    - f. C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
    - g. Loss Prevention Data Sheets: I-49, Perimeter Flashing.
  - 2. National Association of Architectural Metal Manufacturers (NAAMM).
  - 3. National Roofing Contractors Association (NRCA):
    - a. Roofing and Waterproofing Manual.
  - 4. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA):
    - a. Architectural Sheet Metal Manual.

#### **1.3 SUBMITTALS**

- A. Product Data:
  - 1. Manufacturer's specifications and other data needed to prove compliance with specified requirements.
  - 2. Manufacturer's installation instructions.

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- B. Shop Drawings: Indicating sizes, configurations, details of attachment to related and adjacent work, materials, and finishes.
- C. Samples:
  - 1. Full range of finish colors for Architect's selection.
  - 2. 12 inch long sample of each specified item with approved finish.
  - 3. Provide full size mockup of all shop built assemblies.

#### **1.4 QUALITY ASSURANCE**

- A. Single Source Responsibility: Fabricator and installer of roof-related flashing and accessories shall be the same as the membrane roof installer.
- B. Comply with governing codes and regulations of authorities having jurisdiction.
- C. Installation Conference:
  - 1. Refer to Section 01 31 00: Project Management and Coordination.

#### **1.5 WARRANTY**

- A. Manufacturer's Product Warranty:
  - 1. Manufacturer's standard 20 year Kynar 500 or Hylar 5000 Finish warranty signed by the manufacturer, with guarantee covering any failure of the fluoropolymer finish during the warranty period.
  - 2. Failure is defined to include, but not be limited to:
    - a. Deterioration of finish, such as fading, discoloring, peeling, cracking, corroding, etc.
  - 3. Correction may include repair or replacement of failed product.
- B. Roofing Contractor's Warranty:
  - 1. Contractor shall warrant the sheet metal work and related work to be free from defects in workmanship and materials, and that the metal flashings will be and remain watertight, for a period of five (5) years from date of Substantial Completion.
  - 2. Defects shall include, but not be limited to:
    - a. Leaking water or bitumen within building or construction.
    - b. Becoming loose from substrate.
    - c. Loose or missing parts.
    - d. Finish failure as defined above.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, handle, and store materials in accordance with manufacturer's instructions.
- B. Handle and store materials and equipment in such a manner as to avoid damage.
- C. No storage of materials shall be permitted on roof areas other than those materials that are to be installed the same day. Any exception must be in written form. Do not place materials or equipment in such a manner as to overload structure.

### **PART 2 PRODUCTS**

#### **2.1 APPROVED MANUFACTURERS**

- A. Manufacturers named within specification are approved for use on the Project providing:
  - 1. Their products meet or exceed the specifications.
  - 2. Company has a minimum of five (5) years' experience manufacturing products of the



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- type specified.
3. Products have been tested in conjunction with roofing membrane system as an assembly and as such has obtained the same approval and rating as the roofing membrane system.
  4. Products are approved for use by the roofing membrane manufacturer.

B. Substitutions shall be in accordance with Division 1 requirements regarding substitutions.

## 2.2 SHEET METAL MATERIALS

- A. General Requirements: Roofing sheet metal system shall have been tested in conjunction with roofing membrane system as an assembly and have the same approval and rating as the roofing membrane system.
- B. Sheet Lead:
  1. Comply with FS QQ-L-201, Grade B:
    - a. Four (4) pound minimum for use at roof drains and soil stacks.
- C. Stainless Steel: ASTM A167, Type 302/304 Soft Temper, No. 2D finish. Minimum thickness 24 gauge, except as otherwise noted.

## 2.3 FASTENERS

- A. Same metal as flashing/sheet metal or other non-corrosive metal or as noted below.
- B. Exposed fasteners shall be self-sealing and gasketed for weathertight installation. (ZAC type)
- C. Match finish of exposed heads with material being fastened.
- D. Mechanical Fasteners:
  1. Nails: Stainless Steel Ring shank, minimum 1-1/2 inches in length with 1/2 inch diameter head.
  2. Washers: Steel washers with bonded rubber sealing gasket.
  3. Screws: Self-tapping sheet metal type of stainless steel or compatible with material being fastened, with hooded integral EPDM washers (ZAC type).
  4. Rivets: Stainless steel and cadmium plated material, closed end type of sizes recommended by sheet metal manufacturer to suit application.
- E. Clips:
  1. Continuous Cleat (coping/fascia): Minimum 20 gauge, G-90 galvanized, stainless steel, or aluminum. Match material of coping/fascia and provide one (1) gauge heavier.

## 2.4 RELATED MATERIALS

- A. Solder: ASTM B32, alloy grade 58, 50 percent tin, 50 percent lead.
- B. Flux:
  1. Phosphoric acid type, manufacturer's standard:
    - a. For Use with Steel or Copper: Rosin flux.
    - b. For Use with Stainless Steel: Acid-chloride type flux, except use rosin flux over tinned surfaces.
- C. Underlayment:

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1. 48 mil minimum, non-reinforced, homogeneous, waterproof, impermeable elastomeric sheeting manufactured by Nervastral, Inc. or Lexsuco.
- D. Adhesives: Type recommended by flashing sheet manufacturer seaming and adhesive application of flashing sheet to ensure adhesion and watertightness.
- E. Metal Accessories: Sheet metal clips, straps, anchoring devices, clamps and similar accessories required for the complete installation of work, matching or compatible with material being installed, non-corrosive, size and gauge recommended by installer to suit application and performance.
- F. Sealant:
  1. Type A:
    - a. Type: One-part, non-sag, moisture-curing polyurethane sealant.
    - b. Approved Products/Manufacturers: "Chem-Calk 900" manufactured by Bostik Construction Products Division, "Vulkem 921" manufactured by Mameco International, Inc., "Dynatrol I" manufactured by Pecora Corporation, "NP 1" manufactured by Sonneborn Building Products, or approved equal.
  2. Type B:
    - a. Type: One-part, neutral-curing, medium-modulus silicone sealant for sealing metal to metal surfaces, i.e. metal edge, cover plates, etc.
    - b. Approved Products/Manufacturers: "Chem-Calk 1200" manufactured by Bostik Construction Products Division, "795 Silicone Building Sealant" manufactured by Dow Corning Corporation, "895 Silicone" manufactured by Pecora Corporation, "Omniseal" manufactured by Sonneborn Building Products, "Spectrem 2" manufactured by Tremco Incorporated, or approved equal.
- G. Grout - Pitch Pans:
  1. Type: Quick-setting, non-shrink, non-metallic, high strength formula complying with ASTM C1107.
  2. Approved Products/Manufacturers: "Sure Grip High Performance Grout" manufactured by Dayton Superior Corporation, "Premier Quick-Trim" manufactured by L & M Construction Chemicals, Inc., "Masterflow" manufactured by Master Builders, Inc., "SonnogROUT 10K" manufactured by Sonneborn Building Products, or approved equal.
- H. Pitch Pan Filler:
  1. Type: Pourable polyurethane sealer, approved by roofing system manufacturer.
  2. Approved Products/Manufacturers: "Quick Pitch Sealer" manufactured by U.S. Intec, "SPM Pourable Sealer" manufactured by Johns Manville, or approved equal.
- I. Termination Bar:
  1. Material: Extruded aluminum bar with flat profile.
  2. Size: 1/8 inch thick by one (1) inch wide with factory punched 1/4 inch x 3/8 inch oval holes spaced six (6) inches on center.
  3. Approved Product/Manufacturer: "TB 125" manufactured by TruFast Corp., or approved equal.

## 2.5 FABRICATION

- A. Except as otherwise indicated, fabricate work in accordance with SMACNA Architectural Sheet Metal Manual and other recognized industry practices and reviewed shop drawings. Form all flashings, receivers and counterflashings in accordance with standards set forth in the NRCA roofing manual and SMACNA.
- B. Comply with manufacturer's installation instructions and recommendations.

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- C. Unless noted otherwise, fabricate perimeter edge/fascia, scuppers, gutters, downspouts, copings, counterflashings, wind clips, and trim from pre-finished aluminum sheet steel.
- D. Shop fabricate work to greatest extent possible. Fabricate inside and outside corners for metal edges, counterflashing, and coping caps of equal length – minimum 2 foot lengths.
- E. Fabricate items to size and dimensions as indicated on the drawings. Limit single-piece lengths to ten (10) feet.
- F. Fabricate for waterproof and weather-resistant performance; with expansion provisions for running work sufficient to permanently prevent leakage, damage or deterioration of the work.
- G. Integrate flashing in a manner consistent with detailing. Form work to fit substrates.
- H. Make angle bends and folds for interlocking metal with full regard for expansion and contraction to avoid buckling or fullness in metal after installation.
- I. Fabricate items with straight lines, sharp angles, smooth curves, and true levels. Avoid tool marks, buckling, and oil canning.
- J. Fold back edges on concealed side of exposed edge to form hem.
- K. Unless noted otherwise, lap joints minimum one (1) inch. Rivet and solder joints on parts that are to be permanently and rigidly assembled.
- L. Seams:
  - 1. Wherever possible, fabricate non-moving seams in sheet metal with flat-lock seams and end joints.
  - 2. Pre-finished Galvanized Steel: Seal pre-finished metal seams with rivets and silicone sealant.
  - 3. Metal Other than Aluminum: Tin edges to be seamed, form seams, and solder.
- M. On Kynar 500 or Hylar 5000 pre-finished metal, surface sand metal flanges prior to applying any primers. Prime all metal in contact with bituminous material.
- N. Backpaint all concealed metal surfaces with bituminous paint where expected to be in contact with cementitious materials or dissimilar metals.
- O. Expansion Provisions: Where lapped or bayonet type expansion provisions in work cannot be used or would not be sufficiently waterproof or weatherproof, form expansion joints of intermeshing hooked flanges, not less than one (1) inch deep filled with mastic sealant concealed within joints.

## 2.6 FABRICATED ITEMS

- A. Metal Flashings (Minimum ten (10') foot lengths):
  - 1. Through wall Receiver Tray: Minimum 24 gauge stainless steel, through wall receivers shall not extend past the face of the exterior veneer more than  $\frac{3}{4}$ ".
  - 2. Counterflashing: Minimum 24 gauge stainless steel.
- B. Wind Clips: Minimum 24 gauge stainless steel (or match material of counterflashing), one (1) inch wide by length to engage counterflashing a minimum of 1/2 inch. To be installed at all wall flashings and at curb flashing lengths longer than 5 feet.

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- C. Roof Penetrations:
  - 1. Umbrella Counterflashing: Two-piece construction of minimum 24 gauge stainless steel, fabricated in accordance with drawings or project requirements.
  - 2. Pitch Pans:
    - a. 24 gauge stainless steel.
    - b. Fabricate to provide installed minimum clear inside perimeter dimension of two (2) inches on each side of penetrating element.
    - c. Fabricate pans to at least six (6) inches above the finished roof membrane and with 1/4 inch hem at top edge and with four (4) inch flanges. Round all corners of flange.
    - d. Fabricate metal bonnets for all pans, NO EXCEPTIONS. Fabricate bonnets with metal compatible with metal to which bonnet is to be attached. On beams and other steel, weld in place bonnets fabricated from 1/4 inch steel plate. Draw band bonnets fabricated from 22 gauge stainless steel may be used on circular projections.
- D. Metal Edge:
  - 1. Minimum 0.040 inch thick pre-finished aluminum formed in maximum ten (10) foot lengths, with six (6) inch wide cover plates of same profile, four (4) inch flange, maximum seven (7) inch fascia, 3/4 inch gravel stop.
  - 2. Provide expansion slip joints at maximum 20 feet on center.
  - 3. Shop fabricate all interior and exterior corners. Fabricate exterior corners with 18 inch minimum to four (4) foot maximum legs. Lap, rivet, and seal prior to delivery to jobsite.
  - 4. Fabricate to sizes and dimensions as indicated on drawings with a minimum one (1) inch coverage past top of wall. Refer to SMACNA Fig. 2-5A.
  - 5. Provide mock-up for Architect's approval prior to fabrication.
- E. Continuous Cleats: Continuous strips, same material and profile, minimum one gauge heavier of item which cleats attach.
- F. Vent Hoods, Sleeves, Penetration Flashings, and Accessories: Minimum 24 gauge stainless steel, or as shown or directed otherwise.
- G. Angle Termination Bar: Aluminum pressure bar 1/8 inch x one (1) inch.
- H. Vent Pipe Flashing: Four (4) pound lead. Provide proper size to fold down inside of pipe a minimum of one (1) inch.
- I. Roof Drain Flashing: Four (4) pound lead, minimum 30 inches by 30 inches.
- J. Coping:
  - 1. Minimum 0.040 inch thick pre-finished aluminum, with six (6) inch wide cover plates of same profile.
  - 2. Fabricate as outlined in SMACNA; Refer to Figure 3-4 A.
  - 3. Provide tapered substrate to slope to one (1) side, and cover with waterproof membrane.
  - 4. Install with continuous cleat one (1) side and fasten other side.
- K. Pipe Box Cover: 24 gauge stainless steel.
- L. Heat Exhaust Curbs and Hoods: 22 gauge stainless steel.
- M. Expansion Joint Cover: Minimum 24 gauge stainless steel (Provide pre-finished metal at perimeter edge end termination.)

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## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Verify substrates are smooth and clean to extent required to perform sheet metal work.
- B. Verify roof openings, curbs, pipes, sleeves, ducts or vents through roof are solidly set in place.
- C. Verify that reglets, nailers, cants, and blocking to receive sheet metal are in place and free of concrete and soil.
- D. Do not start work until conditions are satisfactory.

### **3.2 PREPARATION**

- A. Field measure site conditions prior to fabrication work.
- B. Install starter and edge strips and cleats before starting installation.

### **3.3 INSTALLATION**

- A. Install sheet metal with lines, arises, and angles sharp and true, and plane surfaces free from objectionable wave, warp, or buckle. Exposed edges of sheet metal shall be folded back to form 1/4 inch hem on concealed side from view. Finished work shall be free from water retention and leakage under all weather conditions. Pre-fabricated corners or transitions are required at changes in direction, elevation, or plane and at intersections. Locate field joints not less than 12 inches, nor more than three (3) feet from actual corner. Laps shall be one (1) inch, riveted and soldered at following locations:
  - 1. Pre-fabricated corners.
  - 2. Transitions.
  - 3. Changes in direction, elevation, and plane.
  - 4. At intersections.
- B. Anchor units of work securely in place to prevent damage or distortion from wind or buckling. Provide for thermal expansion of metal units; conceal fasteners wherever possible; and set units true to line and level as indicated. Install work with laps, joints, and seams which are permanently watertight and weatherproof.
- C. Install fabricated sheet metal items in accordance with manufacturer's installation instructions and recommendations and with SMACNA Architectural Sheet Metal Manual.
- D. Separations: Provide for separation of metal from dissimilar metal or corrosive substrates by coating concealed surfaces with zinc chromate, bituminous coating, or other permanent separation at locations of contact as recommended by manufacturer or fabricator. Do not use materials which are incompatible with roofing system.
- E. Continuous Cleat: At exposed edges of perimeter edge, fascias, cap flashings, and where required, attach continuous cleat at six (6) inches on center with appropriate fasteners.
- F. Gravel Guard/Fascia:
  - 1. Install with expansion joints 10 feet o.c., 1/2 inch expansion leeway, with cover plate.
  - 2. Set in asphalt mastic and fasten into nailer at 3 inches o.c. staggered.
  - 3. Buff sand Kynar surface of flange and prime.
  - 4. Strip in flange with specified stripping plies set in hot bitumen extending 3 inches from

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outer edge of flange to at least 3 inches inward towards gravel stop. Provide finish stripping ply of modified bitumen base ply in hot bitumen extending 6 inches from the outer edge of the flange and butt base of gravel stop.

- G. Counterflashing:
1. Do not use surface mount counterflashing except as noted in drawings.
  2. Set in through wall with receiver and spring lock counterflashing, as detailed in drawings and to NRCA roofing manual, SMACNA standards.
  3. Coordinate installation of through-wall flashing with the masonry contractor.
  4. Seal through-wall in conjunction with masonry wall waterproofing.
  5. Install wind clips 30 inches o.c. at all counterflashing over five (5) feet in length.
- H. Pitch Pans, Metal Flanges:
1. Apply mastic under pitch pan or metal flashing flange at least 1/2 pound per linear foot.
  2. Prime all metal flanges with asphalt primer prior to flashing installation.
  3. Clean all projections enclosed in pitch pans in any manner suitable and coated with a rust inhibitive coating as approved by the Architect. Coating shall be allowed to dry prior to pitch pan fill.
  4. Fill base of pitch pans with grout or cementitious binder and allow to cure.
  5. Top Finish Fill: Self-leveling, one-part urethane; at least two (2) inches to top of pitch pan sides.
  6. Strip in pitch pan flanges with two strips of specified stripping plies set in hot bitumen extending three (3) inches from the outer edge of the flange to at least three (3) inches inward toward base of pitch pan. Provide finish stripping ply of SBS modified bitumen membrane in hot bitumen extending six (6) inches from the outer edge of the flange and butt to base of pitch pan.
- I. Sanitary Vent Stacks:
1. Prime top and bottom flanges of lead flashing sleeve. Set flange in uniform troweling of plastic roof cement. Prime top side of flange to receive strip-in membrane.
  2. Fold lead sleeve down inside of pipe a minimum of one (1) inch. Apply a continuous bead of sealant on inside of pipe prior to folding lead sleeve.
- J. Roof Drains:
1. After membrane installation, prime bottom of lead flashing sheet and set in uniform bed of plastic roof cement at specified locations.
  2. Extend lead flashing into drain bowl or pipe a minimum of two (2) inches and over top of piping/bowl connection, if possible. Apply a continuous bead of specified Type A sealant, at intersection of pipe and drain bowl.
  3. If drain bowl and pipe connection is contaminated with bituminous material, strip-in area with three (3) coursing of plastic roof cement and fabric.
  4. Prime top of lead flashing sheet to receive strip-in membrane.
- K. Expansion Joint:
1. Construct wood curbs as shown on drawings and as outlined in the NRCA and SMACNA Manuals.
  2. Install underlayment, form envelope, and secure underlayment to curb. Fill envelope with compressible insulation.
  3. Securely fasten expansion joint cover to curb with grommetted fasteners spaced six (6) inches on center.
  4. Taper expansion joint down at the metal edge.
- L. Coping:
1. Install wood nailers as shown on drawings.
  2. Install metal cleats with appropriate fasteners spaced six (6) inches on center.
  3. Install underlayment over the wood substrate. Lap ends minimum of six (6) inches and

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- secure membrane in place. Seal laps with appropriate adhesive.
4. Install metal coping allowing 1/2 inch spaces between segments. Lock coping onto cleat and install appropriate fasteners through the interior fascia spaced 24 inches on center in enlarged holes.
  5. Install cover plate centered over coping joint in continuous beads of specified Type B sealant, placed approximately one (1) inch from cover edges. Refer to SMACNA for alternate joints as required by length.
  6. Install appropriate fastener through neoprene washer and cover plate between coping segments.
  7. Accommodate building wall expansion joints by terminating coping joints and cleats either side of expansion joint. Do not run coping or cleats continuous across joints. Install coping cover plate to span across joint and lap coping on each side of joint a minimum of four (4) inches. Fasten cover plate on one (1) side of joint only (provide wall flashing membrane up and over parapet wall in accordance with manufacturer's detail).

### **3.4 CLEANING AND PROTECTION**

- A. Remove flux and residual acid immediately by neutralizing with baking soda and washing with clean water. Leave work clean of stains.
- B. Remove scraps and debris and leave work area clean.
- C. Clean exposed metal surfaces, removing substances which might cause corrosion of metal or deterioration of finishes. Paint areas where finish is damaged on pre-finished metal by painting with a compatible paint in color to match undamaged finish.
- D. Prime soldered area of phosphatized metal after cleaning to prevent rusting.
- E. Paint metal flashings that have been soiled with bitumen with aluminized paint.
- F. Clean other work damaged or soiled by Work of this Section.
- G. Protect finished work from damage.

**END OF SECTION 07 62 00**



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## **SECTION 07 92 00 JOINT SEALANTS**

### **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 requirements including but not limited to:
  1. Control and expansion joints on exposed interior and exterior surfaces.
  2. Perimeter joints between wall surfaces and frames of interior and exterior doors and openings.
  3. Joints between plumbing fixtures and adjoining walls, floors, and counters.
  4. Joints indicated or as necessary.
  5. Accessories necessary for a complete installation.
- B. Related Sections:
  1. Section 05 50 00: Metal Fabrications.
  2. Section 08 11 13: Hollow Metal Doors and Frames.
  3. Section 08 80 00: Glazing.
  4. Section 09 90 00: Painting and Coating.

#### **1.3 SUBMITTALS**

- A. Product Data:
  1. Technical data for each joint sealant product. Data to indicate elasticity and durability of each joint sealant product. Submit written certification from manufacturers of sealants attesting products are suitable for use indicated, verified through in house testing laboratory:
    - a. Written certification from manufacturers of joint sealants attesting that products comply with specification requirements and suitable for use indicated verified through manufacturers testing laboratory within the past 36 months or since most recent reformulation, whichever is most recent:
      - 1) Complete instructions for handling, storage, mixing, priming, installation, curing and protection of each type of sealant.
      - 2) Manufacturer's letter, clearly indicating proposed lot numbers of each sealant supplied and expiration date sequence.
      - 3) Instructions for handling, storage, mixing, priming, installation, curing, and protection of each type of sealant.
  2. Recycled Content:
    - a. Indicate recycled content; indicate percentage of preconsumer and postconsumer recycled content per unit of product.
    - b. Indicate relative dollar value of recycled content product to total dollar value of product included in project.
    - c. If recycled content product is part of an assembly, indicate the percentage of recycled content product in the assembly by weight.
    - d. If recycled content product is part of an assembly, indicate relative dollar value of recycled content product to total dollar value of assembly.
  3. Local/Regional Materials:
    - a. Sourcing location(s): Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.



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- b. Manufacturing location(s): Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
  - c. Product Value: Indicate dollar value of product containing local/regional materials; include materials cost only.
  - d. Product Component(s) Value: Where product components are sourced or manufactured in separate locations, provide location information for each component. Indicate the percentage by weight of each component per unit of product.
- 4. VOC Data: Submit manufacturer's product data for sealants. Indicate VOC limits of the product. Submit MSDS highlighting VOC limits.
- 5. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
- B. Samples:
  - 1. Provide color samples from full manufacturer's full range for each type of sealant specified for Architect's review.
- C. Certificates and Reports:
  - 1. Product Certificates: Manufacturer's product certificate for each kind of joint sealant and accessory.
  - 2. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.
  - 3. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
  - 4. Preconstruction Compatibility and Adhesion Test Reports:
    - a. From sealant manufacturer, indicating the following:
      - 1) Materials forming joint substrates and sealant backings have been tested for compatibility and adhesion with sealants.
      - 2) Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
  - 5. Preconstruction Field Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified.
  - 6. Field Adhesion Test Reports: For each sealant application tested.

## 1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
  - 1. Firm having minimum 5 years documented experience and specializes in the installation of sealants:
    - a. Exposed sealant work (sealants used for air and weatherseals external at perimeter, metal panel to panel joints) shall be performed by a single (i.e. one) firm specializing in the installation of sealants who has successfully produced work comparable to project.
    - b. Concealed sealant work (sealants which are internal to skylights, and providing an air seal) shall be the responsibility of the subcontractor providing erection of the respective system.
- B. Source Limitations: Obtain each type of joint sealant from a single manufacturer.
- C. Product Testing:
  - 1. Test joint sealants using a qualified testing agency:
    - a. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
    - b. Test according to SWRI Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion

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under cyclic movement, adhesion in peel, and indentation hardness.

- D. Environmental Requirements:
  - 1. Toxicity/IEQ:
    - a. Comply with applicable regulations regarding toxic and hazardous materials:
      - 1) VOC Content of Interior Sealants - Sealants and sealant primers complying with limits for VOC content for SCAQMD when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
        - a) Sealants: 250 g/L.
        - b) Sealant Primers for Nonporous Substrates: 250 g/L.
        - c) Sealant Primers for Porous Substrates: 775 g/L.
    - b. Sealants containing aromatic solvents, fibrous talc, formaldehyde, halogenated solvents, mercury, lead, cadmium, chromium and their compounds, are not permitted.

## 1.5 WARRANTY

- A. Written warranty, signed by Installer agreeing to repair or replace elastomeric joint sealant work which has failed to provide a weathertight system within specified warranty period:
  - 1. Warranty Period: Five years from date of Substantial Completion.
- B. Written warranties (weatherseal and stain resistance), signed by sealant manufacturer agreeing to furnish joint sealants to repair or replace those that fail to provide airtight and watertight joints, or fail in adhesion, cohesion, abrasion resistance, stain resistance, weather resistance, durability, or appear to deteriorate in manner not specified in the manufacturer's data as an inherent quality of the material within specified warranty period:
  - 1. Warranty Period: 5 years from date of Substantial Completion.
- C. Warranties specified exclude deterioration or failure of sealants from:
  - 1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
  - 2. Disintegration of joint substrates from natural causes exceeding design specifications.
  - 3. Mechanical damage caused by individuals, tools, or outside agents.
  - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials in compliance with manufacturer written instructions to prevent deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Compatibility: Provide joint sealants, backings, and related materials compatible with one another and with joint substrates under conditions of service and application, as stated by sealant manufacturer's published data, and as substantiated by the manufacturer for each application through testing.

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- B. Liquid Applied Sealants: Comply with ASTM C 920 and requirements indicated for each liquid applied sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- C. Stain Test Response Characteristics: For sealants in contact with porous substrates, provide nonstaining products that have undergone testing according to ASTM C 1248 and do not stain porous joint substrates.
- D. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- E. Colors: For fully concealed joints, provide standard color of sealant that has the best overall performance characteristics for the application shown. For exposed joints, submit color samples to architect for approval, from manufacturer's full line of standard colors.
- F. Manufacturer's Representative: Use sealant produced by manufacturer who agrees to send a qualified technical representative to site upon request for the purpose of rendering advice concerning the recommended installation of manufacturer's materials.
- G. Sealants: Self leveling compounds for horizontal joints in pavements and nonsag compounds elsewhere except as shown or specified.
- H. Silicone Sealant:
  - 1. Comply with ASTM C920, Type M, Grade NS, Class 25; use NT, M, A and O:
    - a. Use: Typical joints between masonry, metals, glass and plastics (Two part silicone sealants).
    - b. Properties: Performance: Nonstain, nonbleed, nonstreaking to sealed and adjacent substrates. The minimum pli value after 7 day immersion shall not be less than 13 when tested in strict accordance with ASTM C794 Adhesion and Peel.
    - c. Cure System and Oil Content: Neutral Cure System specifically manufactured with controlled oil content to eliminate oil migration into sealed substrates and residue rundown over and onto adjacent substrates.
    - d. Product and Manufacturer: Dow Corning; 756 Silicone Building Sealant - HP with Additive.
- I. Silicone Sealant:
  - 1. ASTM C 920, Type S, Grade NS, Class 50, for Use NT:
    - a. Use: Typical joints between masonry, metals, glass and plastics (Single component sealants).
    - b. Properties: Performance: Nonstain, nonbleed, nonstreaking to sealed and adjacent substrates.
    - c. Cure System and Oil Content: Neutral Cure System specifically manufactured with controlled oil content to eliminate oil migration into sealed substrates and residue rundown over and onto adjacent substrates.
    - d. Product and Manufacturer:
      - 1) BASF Building Systems; Omniseal 50.
      - 2) Dow Corning Corporation; 756 SMS, 791, 795, 995 as applicable.
      - 3) GE Advanced Materials, Silicones; SilGlaze II SCS2800, SilPruf NB SCS9000, SilPruf SCS2000, or UltraPruf II SCS2900 as applicable.
      - 4) Pecora Corporation, as applicable.
      - 5) Sika Corporation, Construction Products Division; SikaSil-C995.
      - 6) Tremco, as applicable.
      - 7) Comparable product.
- J. Polyurethane Sealants:

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1. ASTM C920, Type M, Grade NS, Class 25; use NT, M, A and O:
  - a. Use: Typical Wall and Floor Joints (Two part polyurethane sealants). Use at concrete joints.
  - b. Properties: Performance: Nonstain, nonbleed, nonstreaking to sealed and adjacent substrates.
  - c. Products and Manufacturers:
    - 1) BASF Building Systems; Sonolastic NP-2.
    - 2) Pecora Corporation; Dynatred.
    - 3) Sika Corporation, Construction Products Division; Sikaflex 2c NS or Sikaflex 2c NS TG as applicable.
    - 4) Tremco, as applicable.
    - 5) Comparable product.
  
- K. Two Part Polyurethane Sealants:
  1. ASTM C920, Type M, Grade NS, Class 50; use NT, M, A and O:
    - a. Use: Typical Wall and Floor Joints (Two Part Polyurethane Sealants).
    - b. Properties: Performance: Nonstain, nonbleed, nonstreaking to sealed and adjacent substrates. The minimum pli value after 7 day immersion shall not be less than 13 when tested in strict accordance with ASTM C794 Adhesion in Peel.
    - c. Products and Manufacturers:
      - 1) BASF Construction Chemicals; NP 2.
      - 2) Pecora Corporation, as applicable.
      - 3) Schnee-Morehead, Inc.; Permthane SM 7200.
      - 4) Sika Corporation, Inc.; Sikaflex - 2c NS TG.
      - 5) Tremco, as applicable.
      - 6) Comparable product.
  
- L. Mildew Resistant Silicone Sealant:
  1. ASTM C920, Type S, Grade NS, Class 25, Use NT, Substrate uses G, A, and O; and containing fungicide for mildew resistance; acid curing:
    - a. Use: One-part mildew-resistant silicone, formulated with fungicide for sealing interior joints of nonporous substrates around ceramic tile, plumbing fixtures, showers.
    - b. Products - Provide one of the following:
      - 1) BASF Building Systems; Omnipus.
      - 2) Dow Corning; 786 Mildew Resistant Silicone Sealant.
      - 3) GE Silicones; Sanitary SCS 1700.
      - 4) Pecora Corporation, as applicable.
      - 5) Sika Corporation, Inc., as applicable.
      - 6) Tremco, as applicable.
      - 7) Comparable product.
  
- M. Latex Sealant:
  1. Nonelastomeric, one part, nonsag, paintable latex sealant that is recommended for exposed applications on the interior. Complying with ASTM C 834, Type OP (opaque sealants):
    - a. Products are subject to compliance with requirements; provide one of the following:
      - 1) BASF; Sonolastic Sonolac.
      - 2) Pecora Corporation; AC-20 + Silicone.
      - 3) Sika Corporation, Inc., as applicable.
      - 4) Tremco, as applicable.
      - 5) Comparable product.
  
- N. Acoustical Joint Sealant:
  1. Nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings

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in building construction as demonstrated by testing representative assemblies according to ASTM E 90:

- a. Products are subject to compliance with requirements; provide one of the following:
  - 1) BASF, as applicable.
  - 2) Pecora Corporation; AC-20 FTR or AIS-919.
  - 3) Sika Corporation, Inc., as applicable.
  - 4) Tremco, as applicable.
  - 5) USG Corporation; SHEETROCK Acoustical Sealant.
  - 6) Comparable product.
- O. Sealant Backing:
  1. Provide sealant backings that are nonstaining, compatible with joint substrates, sealants, primers, and joint fillers, and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing:
    - a. Cylindrical Sealant Backings: Preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding backings of flexible plastic foam complying with ASTM C 1330, and of type indicated below. Select shape and density of cylindrical sealant backings in consultation with the manufacturer for proper performance in specific condition of use in each case.
    - b. Type C - Closed cell polyethylene foam material with surface skin, nonabsorbent to liquid water and gas, nonoutgassing in unruptured state; provide one of the following:
      - 1) BASF, as applicable.
      - 2) HBR Closed Cell Backer Rod; Nomaco, Inc.
      - 3) Pecora Corporation, as applicable.
      - 4) Sonolastic Closed-Cell Backer-Rod; BASF Construction Chemicals.
      - 5) Tremco, as applicable.
      - 6) Comparable product.
- P. Miscellaneous Materials:
  1. Primer: Material recommended, as verified through compatibility and adhesion testing, by joint sealant manufacturer for the substrates indicated to be sealed.
  2. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with joint substrates.
  3. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and which will not stain nor mar the finish of surface adjacent to joints to which it is applied.
  4. Cork Joint Filler: Resilient and nonextruding, ASTM D1752, Type II.
  5. Bond Breaker Tape: Polyethylene, TFE fluorocarbon, or plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

## PART 3 EXECUTION

### 3.1 PROJECT CONDITIONS

- A. Environmental Limitations:
  1. Do not proceed with installation of joint sealants under the following conditions:
    - a. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 degrees F (4.4 degrees C).
    - b. When joint substrates are wet. Should joints or backing materials become wet, remove and replace backing material with new.

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- B. Joint Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

### 3.2 EXAMINATION

- A. Examine joints indicated to receive joint sealants for compliance with requirements for joint configuration, installation tolerances, and conditions affecting sealant performance. Proceed with installation after unsatisfactory conditions have been corrected.

### 3.3 PREPARATION

- A. Surface Cleaning of Joints:
  - 1. Clean out joints immediately before installing joint sealants to comply with the recommendations of joint sealant manufacturer and requirements:
    - a. Remove foreign material from joint substrates interfering with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), existing joint sealants, oil, grease, water, surface dirt, and frost.
    - b. Clean concrete, masonry, unglazed surfaces of tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil free compressed air.
    - c. Remove laitance and form-release agents from concrete.
    - d. Clean metal, glass, porcelain enamel, glazed surfaces of tile, and other nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming (Elastomeric Sealants Only): Prime joint substrates where recommended in writing by joint sealant manufacturer, based on prior testing and experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### 3.4 INSTALLATION

- A. Silicone Glazing Sealants: Refer to Section 08 80 00: Glazing.
- B. Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- C. Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants applicable to materials, applications, and conditions indicated.
- D. Sealant Backings:
  - 1. Install sealant backings to support sealants during application and at position necessary to produce cross sectional shapes and depths of installed sealants relative



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- to joint widths that allow optimum sealant movement capability:
  - a. Do not leave gaps between ends of sealant backings. Trim for tight fit around obstructions or elements penetrating the joint.
  - b. Do not stretch, twist, puncture, or tear sealant backings.
  - c. Remove absorbent sealant backings that become wet before sealant application and replace with dry sealant backings.
  - d. Install bond breaker tape behind sealants where backings are not used between sealants and back of joints.
- E. Weeps and Vents: Install weeps and vents into joints at the same time sealants are being installed. Locate weeps and vents spaced recommended by sealant manufacturer and the window and curtain wall fabricator and erector. Do not install weeps and vents at outside building corners. Do not install vents at horizontal joints immediately below shelf angles, sills, and through wall flashings.
- F. Sealants:
  - 1. Install sealants by proven techniques resulting in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at same time sealant backings are installed:
    - a. Apply sealants in depth in accordance with manufacturer's recommendations and recommended general proportions and limitations.
    - b. Apply elastomeric sealants, in joints not subject to traffic or abrasion, to a depth equal to 50% of the joint width, but not less than 1/4 inch (6 mm) and not more than 1/2 inch (13 mm).
    - c. Apply nonelastomeric sealants to a depth approximately equal to the joint width.
- G. Tooling of Nonsag Sealants:
  - 1. Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform, beads to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces. Tool exposed surfaces of sealants to the profile shown, or if none is shown, tool slightly concave:
    - a. Use masking tape to protect adjacent surfaces of recessed tooled joints.
    - b. Provide a slight wash on horizontal joints where horizontal and vertical surfaces meet.
    - c. Against rough surfaces or in joints of uneven widths avoid the appearance of excess sealant or compound by locating the compound or sealant well back into joint wherever possible.
- H. Acoustical Sealant Installation: At sound rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer written recommendations.

### 3.5 FIELD QUALITY CONTROL

- A. Field Adhesion Testing:
  - 1. Field test exterior wall joint sealant adhesion to joint substrates:
    - a. Extent of Testing - Test completed and cured sealant joints:
      - 1) Perform 10 tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.
      - 2) Perform 1 test for each 1000 feet (300 m) of joint length thereafter or 1 test

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per each floor per elevation.

2. Test Method: Test joint sealants according to Method A, Field Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
  3. Inspect tested joints and report on the following:
    - a. Whether sealants filled joint cavities and are free of voids.
    - b. Whether sealant dimensions and configurations comply with specified requirements.
    - c. Whether sealants in joints connected to pulled out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer field adhesion hand pull test criteria.
  4. Record test results in a field adhesion test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
  5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure original sealant surfaces are clean and new sealant contacts original sealant.
- B. Evaluation of Field Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

### **3.6 SITE ENVIRONMENTAL PROCEDURES**

- A. Indoor Air Quality: Provide temporary ventilation during work. Coordinate interior application of sealants with interior finishes schedule.

### **3.7 CLEANING AND PROTECTION**

- A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.
- B. Protect joint sealants during and after curing from contact with contaminating substances and from damage so sealants are without deterioration or damage at time of Substantial Completion. If, despite protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

**END OF SECTION 07 92 00**



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## **SECTION 07 95 00 EXPANSION 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 requirements including but not limited to:
  - 1. Expansion joint cover assemblies.
  - 2. Accessories necessary for a complete installation.
- B. Related Sections:
  - 1. Section 09 21 16: Gypsum Board Assemblies.

#### **1.3 SUBMITTALS**

- A. Product Data: Technical data for each type of product including construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.
- B. Shop Drawings:
  - 1. Submit for each expansion joint cover assembly:
    - a. Include plans, elevations, sections, details, splices, block out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
    - b. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.
- C. Expansion Joint Cover Assembly Schedule:
  - 1. Prepared by or under the supervision of the supplier. Include the following information in tabular form:
    - a. Manufacturer and model number for each expansion joint cover assembly.
    - b. Expansion joint cover assembly location cross-referenced to Drawings.
    - c. Nominal, minimum, and maximum joint width.
    - d. Movement direction.
    - e. Materials, colors, and finishes.
    - f. Product options.
    - g. Fire resistance ratings.
- D. Product Test Reports: For each fire resistance rated expansion joint cover assembly, for tests performed by manufacturer and witnessed by a qualified testing agency.

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. Expansion Joint Design Criteria:
  - 1. Type of movement: Thermal and wind sway.
  - 2. Refer to Drawings for placement in wall types and location of expansion joints.

#### **1.5 QUALITY ASSURANCE**

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- A. Regulatory Requirements:
  - 1. Fire resistance ratings:
    - a. Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to UL 2079 or ASTM E1966 by a qualified testing agency:
      - 1) Hose stream test: Wall-to-wall and wall-to-ceiling assemblies shall be subjected to hose stream testing.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- A. Aluminum: ASTM B221, Alloy 6063-T5 for extrusions; ASTM B209, Alloy 6061-T6 for sheet and plate. Apply protective coating on aluminum surfaces in contact with cementitious materials.
- B. Elastomeric Seals: Preformed elastomeric membranes or extrusions to be installed in metal frames.
- C. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.
- D. Moisture Barrier: Flexible elastomeric material. Continuous, waterproof membrane within joint and attached to substrate on sides of joint. Provide where indicated on Drawings.
- E. Nonmetallic, Shrinkage Resistant Grout: ASTM C1107/C1107M, factory packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
- F. Fasteners: Recommended attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

### **2.2 WALL EXPANSION JOINT COVERS**

- A. Metal Plate Wall Joint Cover:
  - 1. Metal cover plate fixed on one side of joint gap and free to slide on other:
    - a. Manufacturers are subject to compliance with requirements, provide products by one of the following:
      - 1) Construction Specialties, Inc. (Model HFR)
      - 2) Architectural Art Manufacturing Inc., a division of Pittcon Architectural Metals, LLC.
      - 3) InPro Corporation (IPC).
      - 4) MM Systems Corporation.
      - 5) Watson Bowman Acme Corp.
      - 6) Balco.
    - b. Application: Wall to wall.
    - c. Fire resistance rating: One hour
    - d. Exposed face: Factory applied silicone face.

### **2.3 ALUMINUM FINISHES**

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm.

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## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the work.
- B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance.
- C. Proceed with installation after correcting unsatisfactory conditions.

### **3.2 PREPARATION**

- A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.
- B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.
- C. Furnish units in longest practicable lengths to minimize field splicing.
- D. Include factory fabricated closure materials and transition pieces, T joints, corners, curbs, cross connections, and other accessories as required to provide continuous expansion joint cover assemblies.

### **3.3 INSTALLATION**

- A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.
- B. Metal Frames:
  - 1. Perform cutting, drilling, and fitting required to install expansion joint cover assemblies:
    - a. Repair or grout block out as required for continuous frame support using nonmetallic, shrinkage resistant grout.
    - b. Install frames in continuous contact with adjacent surfaces.
    - c. Shimming is not permitted.
    - d. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
    - e. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
    - f. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
    - g. Locate anchors at interval recommended by manufacturer, but not less than three inches (75 mm) from each end and not more than 24 inches (600 mm) o.c.
- C. Seals:
  - 1. Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints:
    - a. Provide in continuous lengths for straight sections.
    - b. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.

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- c. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure sensitive tape as recommended by manufacturer.
- D. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.
- E. Terminate exposed ends of expansion joint cover assemblies with field or factory fabricated termination devices.
- F. Fire Resistance Rated Assemblies:
  - 1. Coordinate installation of expansion joint cover assembly materials and associated work so complete assemblies comply with performance requirements:
    - a. Fire barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.
- G. Moisture Barrier Drainage: If indicated, provide drainage fittings and connect to drains.

### **3.4 PROTECTION**

- A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.
- B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion joint cover assemblies. Reinstall cover plates or seals prior to Substantial Completion.

**END OF SECTION 07 95 00**

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

### **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. Provide items shown on the drawings and specified, including, but not limited to the following:
  - 1. Standard steel doors
  - 2. Steel frames for doors, sidelites, transoms, and windows.
  - 3. Louvers and vision lites in steel doors, if shown or required.
- B. Related Sections:
  - 1. Section 07 92 00: Joint Sealants.
  - 2. Section 08 80 00: Glazing.
  - 3. Section 09 21 16: Gypsum Board Assemblies.
  - 4. Section 09 24 00: Cement Plastering.
  - 5. Section 09 90 00: Painting and Coating.
- C. Reference Standards:
  - 1. American National Standards Institute (ANSI):
    - a. A115.IG, Installation Guide for Doors and Hardware.
    - b. A224.1, Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors & Frames.
    - c. A250.8, Recommended Specifications for Standard Steel Doors and Frames. (Formerly SDI-100).
    - d. A250.11, Recommended Erection Instructions for Steel Frames (Formerly SDI-105).
  - 2. ASTM International (ASTM):
    - a. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
    - b. A924, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
    - c. A1008, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
    - d. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
    - e. C1363 - Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
    - f. 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.
    - g. E413 - Standard Classification for Rating Sound Insulation.
  - 3. Hollow Metal Manufacturers Association (HMMA):
    - a. HMMA 802 - Manufacturing of Hollow Metal Doors and Frames.
    - b. HMMA 810 - Hollow Metal Doors.
    - c. HMMA 830 - Hardware Preparation and Locations for Hollow Metal Doors and Frames.
    - d. HMMA 840 - Installation and Storage of Hollow Metal Doors and Frames.

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- e. HMMA 850 - Fire Rated Hollow Metal Doors & Frames.
- f. HMMA 890 - Technical Summary of Hollow Metal by HMMA.
- 4. National Fire Protection Association (NFPA):
  - a. 80, Fire Doors and Fire Windows.
  - b. 252, Fire Tests of Door Assemblies.
- 5. Steel Door Institute – Current Standards:
  - a. Technical Data Series.
- 6. Underwriters Laboratories Inc. (UL):
  - a. Building Materials Directory.
  - b. Listing and Labeling.
  - c. 10B and 10C, Fire Tests of Door Assemblies.
  - d. 1784, Air Leakage Tests of Door Assemblies.
- 7. Intertek Testing, Services (Warnock Hersey, Inc. (WHI):
  - a. Listing and Labeling.

### 1.3 SUBMITTALS

- A. Product Data:
  - 1. Manufacturer's standard details and catalog data demonstrating compliance with specifications and referenced standards.
  - 2. Manufacturer's installation instructions.
- B. Shop Drawings:
  - 1. Indicate complete schedule in detail for each steel door and frame using the same reference number for details and openings as those on the Contract Drawings. If any door is not by the steel door manufacturer only the door opening number should be shown along with the type of door (wood, plastic laminate faced, etc.):
    - a. Show details of construction, installation, connections, anchors, hardware reinforcement, hardware preparation, louvers, and floor and threshold clearances.
- C. Samples are required from non-Steel Door Institute members:
  - 1. 12 inch x 12 inch sample of a fire-rated and non-rated door, cut from corner of door, showing door construction.
  - 2. 12 inch x 12 inch sample of each type of door louver specified or required, showing louver construction.
  - 3. 6 inch long sample of a fire-rated, non-rated frame, and each type of glass stop specified or required, showing corner and construction.
- D. Certificates:
  - 1. Manufacturer's certification that oversized openings are in compliance with specifications.

### 1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: If other than a manufacturer listed under Paragraph 2.1 is proposed for use on the Project, it shall be a company specializing in the manufacturer of steel doors and frames of the type specified for this Project with a minimum of five (5) years' experience.
- B. All steel doors and frames shall be by a single manufacturer, shop drawings to be submitted with manufacturer's insignia which is being supplied.
- C. Furnish steel doors and frames to meet current ANSI/Steel Door Standards.
- D. ANSI/SDI-A250.13 (2003) Testing and Rating of Sever Windstorm Resistant Components

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for Swing Door Assemblies.

- E. ASTM E 330-97, Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.
- F. Comply with ASTM E 283 – Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- G. Regulatory Requirements:
  - 1. Fire-Rated Assemblies:
    - a. Fire-Rated Door, Panel, Frame, and Fire Window Construction:
      - 1) Shall conform to NFPA 252, or UL 10B, as applicable, and acceptable to the code authorities having jurisdiction.
    - b. Fire-Rated Door Construction:
      - 1) Notwithstanding any other requirements of this Specification, provide gauge of metal, method of construction, hardware preparation, reinforcement, and placement, glass opening size, and other specifics required to obtain the specified or required label. The label shall contain the fire resistance rating (20 minute, 45 minute, 1 hour, 1-1/2 hour, 3 hour, etc.) and the designation (A, B, C, D, or E). **Doors with "B" Label shall be 1-1/2 hour.**
      - 2) Fire-rated doors used in a stairway enclosure, shall be so constructed so that the maximum transmitted temperature shall not exceed 450 degrees F above ambient temperature at the end of 30 minutes of the Standard Fire Exposure Test and shall be so noted on the label.
    - c. Fire-Rated Openings:
      - 3) Conform to NFPA 80 for fire-rated class shown or required by code authorities having jurisdiction:
        - a) Units shall be identical to assemblies whose fire resistance characteristics have been determined in accordance with requirements specified under Paragraph C, 01, above, and shall be labeled and listed by UL, WHI, or other inspection and testing agency acceptable to the code authorities having jurisdiction.
        - b) Fire-rated steel doors, panels, frames, and fire windows shall bear permanent labels attesting to fire resistance. At stairway enclosures, provide units listed for 450 degree F maximum temperature rise rating for 30 minutes of exposure.
        - c) Oversized openings shall be constructed in accordance with all applicable requirements for labeled door construction.
        - d) Fire rated door assemblies with gaps in excess of 1/8 inch between door and frame will not comply with NFPA 80.
        - e) Locate label on hinge side of doors and frames so that when door is closed, label is not visible.
        - f) Caution shall be taken to ensure that labels are not removed, damaged or painted over.
        - g) Glass panes shall not exceed sizes allowed whether indicated or not on the drawings.
- H. Wind Loads: Provide hollow metal and door hardware assemblies approved by DSA, including anchorage, capable of withstanding wind load design pressures which are calculated for this project by a registered Architect or Engineer and is part of the construction documents per CBC.
- I. Accessibility Requirements:
  - 1. Comply with applicable requirements:
    - a. Americans with Disability Act of 1990, as amended:

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- 1) 2010 ADA Standards.
  - b. CBC 2019 California Building Code. CCR Title 24, Part 2, as adopted and amended by DSA.
- J. Pre-installation Conference:
1. Refer to Section 01 31 00: Project Management and Coordination.

## **1.5 WARRANTY**

- A. Warrant the Work specified herein for one (1) year against becoming unserviceable or causing an objectionable appearance resulting from either defective or non-conforming materials and workmanship.
- B. Defects shall include, but not be limited to:
1. Use of incorrect materials in opening.
  2. Incorrect labeled components installed within opening.
  3. Noisy, rough or difficult operation.
  4. Failure to meet specified quality assurance requirements.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver and store products in accordance with manufacturer's instructions, and as follows:
1. In manufacturer's original, clearly labeled, undamaged containers or wrappers.
  2. Containers or wrappers shall list the name of the manufacturer and product.
- B. Deliver materials to allow for minimum storage time at the project site. Coordinate delivery with the scheduled time of installation.
- C. Protect products from moisture, construction traffic, and damage:
1. Store under cover in a clean, dry place, protected from weather and abuse.
  2. Store in a manner that will prevent rust or damage.
  3. Store doors in a vertical position, spaced with blocking to permit air circulation.
  4. Do not use non-vented plastic or canvas shelters.
  5. Should containers or wrappers become wet, remove immediately.

## **PART 2 PRODUCTS**

### **2.1 APPROVED MANUFACTURERS**

- A. Manufacturers listed below whose products meet or exceed the specifications are approved for use on the Project. Other manufacturers must comply with Paragraph 1.5, A, Manufacturer Qualifications, must manufacture equivalent products to those specified and comply with requirements of Section 01 25 13: Product options and Substitutions, regarding substitutions to be considered:
1. CECO Door Products, Brentwood, TN; (615) 661-5030.
  2. Curries Company, Mason City, IA; (515) 423-1334.
  3. Pioneer Industries, Inc., Kewanee, IL; (309) 856-6000.
  4. Republic Builders Products Company, McKenzie, TN; (800) 733-3667.
  5. Steelcraft Mfg. Co., Cincinnati, OH; (513) 745-6400.
  6. Approved equal.

### **2.2 MATERIALS, GENERAL**

- A. Steel requirements, all frames to be manufactured of commercial quality, stretcher leveled



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flatness, cold rolled steel per ASTM-A1008 general requirements. Internal reinforcing may be manufactured of hot rolled pickled and oiled steel per ASTM-A1011. Exterior frames and interior frames where shown on drawings or required in damp, moist, humid, and wet areas, i.e., toilets, locker rooms, showers, etc., to be manufactured of commercial quality, stretcher leveled flatness, cold rolled steel and galvanized to 'A-60' minimum coating weight standard per ASTM-A653 and A924, with coating weight of not less than 0.60 ounce per square foot (0.30 ounce per square foot per side).

## 2.3 FRAME FABRICATION

- A. Minimum Gauges:
  - 1. Interior Openings:
    - a. Less than 4 feet-0 inches in Width: 16 gauge.
    - b. 4 feet-0 inches in Width and greater: 14 gauge.
  - 2. Exterior Openings: 14 gauge
- B. Design and Construction:
  - 1. Frames shall be custom made, welded units with integral trim of sizes and shapes shown on approved shop drawings. Frame profile shall match wall thickness where practical, i.e.
  - 2. Frames shall be strong and rigid, neat in appearance, square, true and free of defects, warp and buckle. Molded members shall be clean cut, straight and of uniform profile throughout their length.
  - 3. Jamb depths, trim, profile and backbends shall be as shown on approved shop drawings.
  - 4. Corner joints, including face and inside corners, shall have contact edges closed tight, with trim faces mitered and continuously welded, and stops butted. The use of gussets shall not be permitted. Face of frame shall be ground smooth. Knockdown (KD) frames are not permitted.
  - 5. Minimum depth of stops shall be 5/8 inch.
  - 6. Frames for multiple openings shall have mullion and rail members which are closed tubular shapes having no visible seams or joints. Joints between faces of abutting members shall be securely welded and finished smooth. Mullions shall be key locked removable type. Keys shall be master keyed to Owner's Best system.
  - 7. High Frequency Hinge Reinforcement: Provide high frequency hinge reinforcements at door openings 48-inch and wider with mortise/butt type hinges only at top hinge location to deter against hinge reinforcement sag.
  - 8. Provide countersunk flat or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops; provide security head screws at exterior locations.
  - 9. Provide A60 Galvanized coating at frames in restrooms and locker rooms with showers/Jacuzzi, clean areas such as kitchen rooms.
  - 10. Electrical Knock Out Boxes:
    - a. Factory weld 18 gage electrical knock out boxes to frame for electrical hardware preps; included but not limited to electric thru wire hinges, electrical raceways, door position switches, electric strikes, jamb mount card readers, and magnetic locks as noted in door hardware sets in Division 08 Openings:
      - 1) Electrical knock out boxes are required at door position switches, electric strikes, card readers, and middle hinge locations Openings.
      - 2) Provide electrical knock out boxes with 3/4-inch knockouts.
      - 3) Conduit to be coordinated and installed in field from middle hinge box and strike box to door position box.
      - 4) Electrical knock out boxes to comply with NFPA requirements and fit electrical door hardware as specified in hardware sets in Division 08 Openings.
      - 5) Electrical knock out boxes for continuous hinges should be located in the

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- center of the vertical dimension on the hinge jamb.
- 6) Provide field installed conduit per Division 28 section for standardized plug connectors to accommodate up to twelve (12) wires as required for electrified door hardware specified in hardware sets in Division 8 Openings. Provide sufficient number of concealed wires to accommodate electric function of specified hardware. Wire nut connections are not acceptable.
11. Hardware Reinforcements:
    - a. Frames shall be mortised, reinforced, drilled and tapped at factory for fully template mortised hardware in accordance with approved hardware schedule and templates provided by Section 08 71 00: Door Hardware. Where surface-mounted hardware is to be applied, frames shall have reinforcing plates only.
    - b. Minimum thickness of hardware reinforcing plates shall be as follows:
      - 1) Hinge and pivot reinforcements (1-1/4 inch x 10 inch minimum size): 7 gauge.
      - 2) Strike reinforcements: 12 gauge stiffeners.
      - 3) Flush bolt reinforcements: 12 gauge.
      - 4) Closer reinforcements: 12 gauge.
      - 5) Reinforcements for surface-mounted hardware, hold-open arms, surface panic devices: 12 gauge.
  12. Floor Anchors: Minimum 14 gauge, securely welded inside each jamb, with holes for floor anchorage.
    - c. Frames for installation in wood stud partitions shall be provided with steel anchors of suitable approved design, not less than 16 gauge thickness, securely welded inside each jamb as follows:
      - 1) Frames up to 7 feet-6 inch height - Four (4) anchors.
      - 2) Frames 7 feet-6 inch to 8 feet-0 inch height - Five (5) anchors.
      - 3) Frames over 8 feet-0 inch height - Four (4) anchors plus one (1) additional for each 2 feet or fraction thereof over 8 feet-0 inches.
  13. Dust Cover Boxes: Shall be of not less than 26 gauge steel and shall be provided at all mortised hardware items.
  14. Steel Spreader: Shall be provided on all frames, temporarily attached to bottoms of both jambs for bracing during shipping and handling.
  15. Loose Glazing Stops: Shall be of cold rolled steel, not less than 20 gauge, butted at corner joints and secured to the frame with countersunk cadmium or zinc-plated screws. Loose stops at exterior frames shall be placed on the interior side of the frames.
- C. Frame Color: Field painted under Section 09 90 00: Painting and Coating to match face of door.

## 2.4 DOOR FABRICATION

- A. Minimum Gauges:
  1. Interior Doors: 0.047 inch or 18 gauge (16 gauge for high frequency doors).
  3. Exterior Doors: 0.059 inch or 16 gauge (14 gauge for windstorm rated doors).
- B. Design and Construction:
  1. Types: Doors shall be custom fabricated, of types and sizes shown on approved shop drawings, and shall be seamless face construction with no visible seams or joints on vertical edges with fully welded seams free from blemishes and defects. Thickness: Shall be 1-3/4 inch, unless specifically noted or shown otherwise.
  4. Exterior Doors: Provide doors with 22 gage steel z-channels placed at 6 inches apart with foamed in place polyurethane core, with a thermal insulation calculated R factor of 11.01 per ASTM C518 Standards.
  5. Fabrication:
    - a. Doors shall be strong, rigid and neat in appearance, free from warpage and buckle.

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- b. Corner bends shall be true and straight and of minimum radius for gage of metal used.
- c. Provide stiffeners with polystyrene core spaced maximum six (6) inches on center and extending full height of door.
- d. Fill interior with noncombustible fiberglass insulation. Use mineral board filler as required for labeled doors.
- e. Faces shall be joined at vertical edges of door by a continuous weld extending full height of door. Welds shall be ground, filled and dressed smooth to provide a smooth flush surface.
- f. Top and bottom edges of doors shall be closed with a continuous recessed steel channel not less than 16 gauge, extending full width of door and spot weld to both faces. Exterior doors shall have an additional flush closing channel at top and bottom edges. Openings shall be provided in the bottom closure channel at top and bottom edges. Openings shall be provided in the bottom closure of exterior doors to permit the escape of entrapped moisture.
- g. Electrical Raceways: Provide raceways for standardized plug connectors to accommodate up to twelve (12) wires as required for electrified door hardware specified in hardware sets in Division 8 Openings. Provide sufficient number of concealed wires to accommodate electric function of specified hardware. Wire nut connections are not acceptable.
- h. Doors within in wet or humid areas shall have a top cap and solid foam interior core to prevent internal moisture accumulation and galvannealed.
- i. Edge profile shall be provided on both vertical edges of door as follows:
  - 1) Single-Acting Swing Doors: Beveled 1/8 inch in 2 inches.
- j. Hardware Reinforcements:
  - 1) Doors shall be mortised, reinforced, drilled and tapped at factory for fully template hardware, in accordance with the approved hardware schedule and templates provided by Section 08 71 00: Door Hardware. Where surface-mounted hardware is to be applied, doors shall have reinforcing plates only.
  - 2) Minimum gauges for hardware reinforcing plates shall be as follows:
    - a) Hinge & pivot reinforcements: 7 gauge.
    - b) Reinforcements for lock face, flush bolts, concealed holders, concealed or surface-mounted closers: 12 gauge.
- 6. Glass Moldings and Stops: Loose stops shall be not less than 20 gauge steel, with butt corner joints, secured to frame opening by countersunk screws. Snap-on attachments will not be acceptable.
- 7. Louvers: Shall be inverted "V" blade, sightproof type, unless noted otherwise.
- 8. Edge Clearances:
  - a. Between Door and Frame at Head and Jambs: 1/8 inch.
  - b. At DoorSills with No Threshold: 5/8 inch to 3/4 inch above finished floor.
  - c. At DoorSills with Threshold: As required to suit threshold.
  - d. Between Meeting Edges of Double Doors: 1/8 inch.
- C. Finish:
  - 1. Shop paint steel (whether galvanized or ungalvanized) stops and accessories as follows:
    - a. Clean surfaces free of mill scale, rust, oil, grease, dirt and other foreign matter.
    - b. Chemically treat surfaces and apply one (1) coat of an approved baked-on rust-inhibitive primer paint to provide a minimum 0.5 mil dry film thickness.
  - 2. Field painted under Section 09 90 00: Painting and Coating.

## 2.5 LABELED DOORS AND FRAMES

- A. Labeled doors and frames shall be provided for openings requiring fire protection ratings as scheduled and to comply with NFPA 80. Such doors and frames shall be constructed as tested and approved by UL, WHI, or other nationally recognized testing agency having a

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factory inspection service and approved by code authorities having jurisdiction and shall bear the appropriate permanent label.

- B. If any door or frame scheduled to be fire-rated cannot qualify for appropriate labeling because of its size, design, hardware or other reason; the Architect shall be so advised before fabrication work on that item is started. Indicate and highlight on shop drawing.

## **PART 3 EXECUTION**

### **3.1 COORDINATION**

- A. Coordinate the Work of this Section.
- B. Coordinate hardware installation with opening construction. Finish hardware is specified in Section 08 71 00.
- C. Coordinate doors, frames, and windows with glazing specified in Section 08 80 00: Glazing.
- D. Coordinate doors and frames with painting specified in Section 09 90 00: Painting and Coating.

### **3.2 INSTALLATION**

- A. Separate dissimilar metals. Protect against galvanic action.
- B. Frames:
  - 1. Anchorage and Connections: Secure to adjacent construction. Where practical, interior door frames shall be flush with the pull side wall to minimize or eliminate the reveal and allow full 180 degree door swing.
  - 2. Install frames in accordance with manufacturer's instructions and install labeled frames in accordance with NFPA 80.
  - 3. Frame Spreader Bars: Leave intact until frames are set perfectly square and plumb and anchors are securely attached.
  - 4. Remove hardware, with the exception of prime-coated items, tag box, and reinstall after finish paint Work is completed. Do not remove or paint over labels on labeled frames.
- C. Doors:
  - 1. Install hardware in accordance with hardware manufacturer's templates and instructions.
  - 2. Install doors in accordance with manufacturer's instructions and install labeled doors in accordance with NFPA 80.
  - 3. Adjust operable parts for correct function.
  - 4. Remove hardware, with the exception of prime-coated items, tag, box, and reinstall after finish paint Work is completed. Do not remove or paint over labels on labeled doors.

### **3.3 ADJUST AND CLEAN**

- A. Adjust doors for proper operation, free from binding or other defects.
- B. Clean and restore soiled surfaces.
- C. Remove scraps and debris, and leave site in clean condition.

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**END OF SECTION 08 11 13**

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## **SECTION 08 11 16 INTERIOR ALUMINUM FRAMING**

### **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 RELATED SECTIONS**

- A. Section 08 06 80 – Glazing Schedule.

#### **1.3 REFERENCES**

- A. AAMA 607.1 – Voluntary Guide Specification and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum.
- B. AAMA 608.1 – Voluntary Guide Specification and Inspection Methods for Electrolytically deposited Color Anodic Finishes for Architectural Aluminum.
- C. AAMA 2604 – Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).
- D. ASTM-B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- E. ASTM-B221 – Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- F. ASTM-D5116 – Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/ Products.
- G. ASTM-D6670 – Standard Practice for Full-Scale Chamber Determination of Volatile Organic Emissions from Indoor Materials/ Products.
- H. ASTM-E90 – Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

#### **1.4 SUBMITTALS**

- A. Must comply with Section 01 33 00 – Submittal Procedures.
- B. Action Submittals/ Informational Submittals.
  - 1. Product Data.
    - a. Submit manufacturer's product data sheets, catalog pages illustrating the products, description of materials, components, fabrication, finishes, installation instructions, and applicable test reports.
  - 2. Shop Drawings.
    - a. Submit manufacturer's shop drawings, including elevations, sections, and details indicating dimensions, tolerances, materials, fabrication, doors, panels, framing, hardware schedule, and finish.
  - 3. Samples.
    - a. Submit manufacturer's door sample composed of door and finish.
    - b. Submit manufacturer's sample of standard colors for door and frame.
    - c. Provide two samples of each type of framing member required, not less than 10" long in Clear 204 R1 finish.
  - 4. Testing and Evaluation Reports.

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- a. Submit testing reports and evaluations provided by manufacturer conducted by and accredited independent testing agency certifying doors and frames comply with specified performance requirements listed in Section 2.04.
- 5. Manufacturer Reports.
  - a. Manufacturer's Project References.
    - 1. Submit list of successfully completed projects including project name, location, name of architect, type, and quantity of doors manufactured.
- C. Closeout Submittals.
  - 1. Operation and Maintenance Manual.
    - a. Submit manufacturer's maintenance and cleaning instructions for doors and frames, including maintenance and operating instructions for hardware.
  - 2. Warranty Documentation.
    - a. Submit manufacturer's standard warranty.

## 1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications.
  - 1. Continuously engaged in manufacturing of doors of similar type to that specified, with a minimum of 25 years concurrent successful experience.
  - 2. Door and frame components must be fabricated by same manufacturer.
  - 3. Evidence of a documented complaint resolution quality management system.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery.
  - 1. Deliver materials to site in manufacturer's original, unopened, containers and packaging.
  - 2. Labels clearly identifying elevations.
  - 3. Inspect frames upon delivery for damage.
    - a. Repair minor damage to polyester finish by using air drying spray enamel of matching color.
    - b. Replace frames that cannot be satisfactorily repaired.
- B. Storage.
  - 1. Store materials in a clean, dry area, indoors in accordance with manufacturer's instructions.
- C. Handling.
  - 1. Protect materials and finish from damage during handling and installation.

## 1.7 WARRANTY

- A. Standard Period.
  - 1. Five years starting on date of shipment.

## PART 2 PRODUCTS

### 2.1 INTERIOR ALUMINUM FRAMING

- A. Manufacturer.
  - 1. Basis of Design: Special-Lite, Inc  
Manufacturer: The Sliding Door
  - 2. Providing complete system from single manufacturer.

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3. Substitutions:
  - a. Substitutions will be considered according to Division 01 Requirements.

## 2.2 DESCRIPTION

- A. Model.
  1. LiteSpace Interior Aluminum Framing.
- B. Materials.
  1. [See 2.05. A.](#)
- C. Perimeter Frame Members.
  1. Rectilinear design with 1-3/4" face.
  2. Overall depth of 2-3/8".
  3. Accommodates framed aluminum doors, sliding frameless glass doors 3/8" or 1/2" thick.
  4. Vertical aluminum mullions.
- D. Frame Member to Member Connections.
  1. Secure joints with fasteners.
  2. Provide hairline butt joint appearance.
  3. No exposed clips for member to member connections.
- E. Glazing.
  1. Thickness.
    - a. 3/8".
  2. Able to accept multiple glazing thicknesses.
  3. Vinyl glazing bulb grey to match extrusions.
  4. Glazing system designed to allow replacement of glass.
  5. Glazing vinyl internal to extrusion to provide clean sight line.
  6. Glass butt joints with polycarbonate glazing channel with integral glazing tape that provides a minimum 120 oz/ inch peel strength.
- F. Anchors:
  1. Anchors appropriate for wall conditions to anchor framing to wall materials.

## 2.3 MATERIALS

- A. Aluminum Members.
  1. Aluminum extrusions made 6061 or 6063 aluminum alloys.
  2. Sheet and plate to conform to ASTM-B209.
  3. Alloy and temper to be selected by manufacturer for strength, corrosion resistance, and application of required finish, and control of color.
- B. Fasteners.
  1. All exposed fasteners will have a finish to match material being fastened.
  2. 410 stainless steel or other non-corrosive metal.
  3. Must be compatible with items being fastened.

## 2.4 FABRICATION

- A. Factory Assembly.
  1. Frame components from the same manufacturer.
  2. Size for frame units, shall be as indicated on the drawings.
  3. All cut edges to be free of burs.
  4. Welding of frames is not acceptable.
  5. Maintain continuity of line and accurate relation of planes and angles.
- B. Shop Fabrication
  1. All shop fabrication to be completed in accordance with manufactures process work instructions.



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2. Quality control to be performed before leaving each department.

## **2.5 FINISHES**

### **A. Frame**

2. Aluminum.
  - a. Anodizing.
    1. Class 2 Anodizing, minimum 0.4 to 0.7 mils thick.
      - a. Color.
        1. Clear 204 R1, AA-M10C12C22A41.

## **2.6 ACCESSORIES**

### **A. Glazing Materials.**

3. Vinyl Glazing Bulb.
  - a. Color
    1. Grey.
4. Polycarbonate Gasket.
  - a. Thickness.
    1. 3/8".
  - b. Glazing Tape.
    1. Installed on Polycarbonate Gasket.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Notify architect of conditions that would adversely affect installation or subsequent use.
- B. Do not proceed with installation until unsatisfactory conditions are corrected.

### **3.2 PREPARATION**

- A. Ensure openings to receive frames are plumb, level, square, and in tolerance.

### **3.3 ERECTION**

- A. Anchor frames securely in place.
- B. Separate aluminum from other metal surfaces with bituminous coatings or other means approved by architect.
- C. Repair minor damages to finish in accordance with manufacturer's instructions and as approved by architect.
- D. Remove and replace damaged components that cannot be successfully repaired as determined by architect.

### **3.4 CLEANING**

- A. Do not use harsh cleaning materials or methods that would damage finish.
- B. Clean once a year or as needed with a non-acidic or alkaline cleaning product.
- C. Light scratches may be removed with a light abrasive, such as ground pumice.

### **3.5 PROTECTION**

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- A. Protect window and frames to ensure that doors will be without damage or deterioration at time of substantial completion.

**END OF SECTION 08 41 13**

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## **SECTION 08 31 13 ACCESS DOORS AND FRAMES**

### **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.
- B. Related Sections:
  - 1. Section 05 50 00: Metal Fabrications.
  - 2. Section 06 10 00: Rough Carpentry.
  - 3. Section 06 83 16: Fiber Reinforced Paneling.
  - 4. Section 08 11 13: Hollow Metal Doors and Frames.
  - 5. Section 09 21 16: Gypsum Board Assemblies.
  - 6. Section 09 30 00: Tiling.
  - 7. Section 09 51 00: Acoustical Ceiling Panels.

#### **1.2 SUMMARY**

- A. Section includes access doors in gypsum board and plaster/stucco soffits, where shown or required.

#### **1.3 SUBMITTALS**

- A. Product Data:
  - 1. Manufacturer's literature, including schedules, charts, installation instructions, and illustrations to indicate the performance, fabrication, procedures, product variations, and accessories.

### **PART 2 PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Manufacturers listed whose products meet or exceed the specifications are approved for use on the Project. Other manufacturers must have a minimum of five (5) years' experience manufacturing access doors meeting or exceeding the specifications and comply with Division 01 requirements regarding substitutions in order to be considered:
  - 1. J. L. Industries, Commerce, CA (Basis of Design for Rated Floors).
  - 2. Karp Associates, Inc., Melville, NY (Basis of Design).
  - 3. The Bilco Company, New Haven, CT.
  - 4. Babcock-Davis, San Lorenzo, CA.
  - 5. Larsen's Manufacturing Co., Minneapolis, MN.
  - 6. Milcor, Grand Rapids, MI.
  - 7. Approved Equal.

#### **2.2 PRODUCTS**

- A. Wall and Ceiling Access Door:
  - 1. Listing: Not required.
  - 2. Size: As shown on the drawings.
  - 3. Hinges: Heavy-Duty Type 316 Stainless Steel Butt hinge.
  - 4. Finish: 20 Ga. Galvanized finish with gray primer on exterior frame, field painting per Section 09 90 00.

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5. Frames: Extruded Aluminum.
6. Doors: Single Leaf.
7. Lock: Knurled knob/key operated latch bolt.
8. Hold open door.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Locate and provide Access Doors in walls (and floors) to construct the wall as indicated on drawings, and provide access doors and panels to fit the wall condition. Maintain designated wall types as indicated on Drawings.

### **3.2 LOCATIONS**

- A. Provide where required by code and where needed to service and maintain equipment.
- B. If not shown on the drawings, consult the Architect before locating in finished spaces.

**END OF SECTION 08 31 13**

## **SECTION 08 32 13 INTERIOR SLIDING GLASS DOORS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section includes glazed aluminum-framed sliding doors and frames.
- B. Related Requirements:
  - 1. Section 08 11 16 – Interior Aluminum Doors and Frames.
  - 2. Section 08 71 00 – Door Hardware.
- C. References:
  - 1. American Society for Testing and Materials (ASTM).
    - a. ASTM B221, Aluminum 6063-T6 Standard Structural Profiles.
    - b. ASTM C1048, Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass.
    - c. ASTM C1172, Laminated Architectural Flat Glass.
    - d. ASTM C1036, Standard Specification for Flat Glass.
  - 2. American Architectural Manufacturers Association (AAMA).
    - a. AAMA 611, Anodized Architectural Aluminum.
  - 3. American National Standards Institute (ANSI).
    - a. ANSI Z97.1-2009, Impact Class A.
  - 4. International Building Code 2015 (IBC 2015).
  - 5. U.S. Consumer Product Safety Commission (CPSC).
    - a. CPSC 16 CFR 1201, Category II, Safety Standard for Architectural Glazing Materials.

#### **1.2 ADMINISTRATIVE REQUIREMENTS**

- A. Field-verify dimensions and clearances for openings scheduled to receive work of this section.
- B. Scheduling:
  - 1. Ordering and Delivery: Order products with sufficient lead time to avoid delays in project schedule.
  - 2. Installation: To extent practical, install work after surrounding finish work is complete. (Last trade in)

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: Include fabrication details, aluminum finishes, glass types, installation and operating instructions for each type of sliding door.
- B. Shop Drawings (If requested by the client, for a fee):
  - 1. Include plans, elevations, details, hardware, operational clearances and accessories. Include keying schedule for locksets.
  - 2. Delegated Design Submittals: For installations not supported from above, provide drawings and calculations signed by an engineer, indicating components and connections, demonstrating compliance with applicable regulations.

- C. Samples for Verification:
  - 1. Extrusions: Approximately 8 inches long, showing finish.
  - 2. Glass: Approximately 3 inches square.
- D. Warranty: Submit sample of manufacturer's standard warranty.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Operation and maintenance data (If frosted glass is selected, please see specific cleaning details). Include Frosted Glass Warning.
- B. Executed warranty.

#### **1.5 QUALITY ASSURANCE**

- A. Installer Qualifications: Installer having minimum 10 years documented experience who is an authorized representative of the manufacturer and is trained and approved for installation of units required.
- B. Non-TSDC Installers: Client provided installers/Licensed in project jurisdiction.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Delivery: Deliver products after space is enclosed and wet work is complete.
- B. Acceptance: Inspect packaging and report noticeable damage to manufacturer within 48 hours of receiving.
- C. Storage: Store in original packaging, up to ten degrees from vertical, on level floor surface.
- D. Handling: Handle in accordance with manufacturer's installation instructions and to prevent damage.

#### **1.7 WARRANTY**

- A. See separate warranty document.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURER**

- A. Basis of Design: Interior sliding glass
- B. Manufacturer: The Sliding Door Company, Inc.  
20235 Bahama St., Chatsworth, CA 91311  
Toll Free: 888-433-1333;
- C. Providing complete system from single manufacturer.
- D. Substitutions:
  - 1. Substitutions will be considered according to Division 01 Requirements.

## 2.2 COMPONENTS

- A. Framing, General:
  - 1. Material: Aluminum extrusions, 6063 alloy.
  - 2. Finish:
    - a. Clear Anodized Aluminum: AAMA 611, Class II.
- B. Beams and Columns: Size shown on Drawings, 0.102 inch minimum thickness.
- C. Top Tracks: 0.064 inch minimum thickness, with number of channels required for door operation indicated.
- D. Bottom Tracks:
  - 1. Aluminum 6063 extrusions, 0.057 inch minimum metal thickness, 0.325 inch high, barrier-free per ADA.
  - 2. Installation: Recessed.
  - 3. Channels: Interlocking tracks with number of channels required for door operation indicated.
  - 4. Finish: Clear Anodized Aluminum: AAMA 611, Class II.
- E. Doors:
  - 1. Stiles and Rails:
    - a. 3 inch wide, 0.051 inch minimum thickness.
  - 2. Mullions:
    - a. Built-In Mullions: **3** inch wide.
      - 1)** For use with Laminated Glass, we highly recommend a maximum of one Built-In mullion per panel.
- F. Glass: Category II Safety Glazing per CPSC 16 CFR 1201.
  - 1. Monolithic Clear Tempered Glass: 5 mm thick, ASTM C1048, Kind FT.

## 2.3 HARDWARE

- A. Handles:
  - 1.** Extended Designer Handle (Brushed Silver - Aluminum) Single, 9" ht
- B. Upper Roller Carriages: Vinyl rollers with steel bearings.
- C. Lower Carriages: Sliding wheel-to-track with locking mechanism and polyoxymethylene (POM) copolymer wheels with steel bearings.
- D. Locks and Latches:
  - 1. Latch Mechanism with 1" Mortise Key Cylinder & Thumbturn for Sliders (Stainless Steel)
  - 2. Wheel Lock (Painted Silver - Aluminum)
  - 3. Lockitron Bolt for Sliders (Stainless Steel)
  - 4. Provide keys as specified in Section 08 71 00 – Door Hardware.
- E. Door Stop: For head or bottom track, as indicated in shop drawings.

## 2.4 FABRICATION AND ASSEMBLY

- A. Door Design:
  - 1. Single light.
- B. Factory Assembly: Fabricate frame components and doors to finished sizes in factory

## **2.5 ACCESSORIES**

- A. Silicone Adhesive (provided by client): Clear, construction grade silicone adhesive.
- B. Fasteners: As indicated in Shop Drawings.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that openings and substrates are acceptable for installation of work of this section.

### **3.2 INSTALLATION**

- A. Install systems according to Shop Drawings and manufacturer's installation instructions.

### **3.3 ADJUSTING, CLEANING AND PROTECTION**

- A. Adjust doors for smooth operation.
- B. Comply with manufacturer's written recommendations for cleaning and maintenance.
- C. Clean aluminum and glass surfaces immediately after installing sliding doors.
- D. Protect surfaces from impact and from contact with contaminating substances resulting from other construction operations. Typically this product is last trade in.
- E. Clean immediately before Substantial Completion.

### **3.4 CLOSEOUT REQUIREMENTS**

- A. Deliver keys as specified in Section 08 71 00 – Door Hardware.
- B. Deliver executed Warranty.

**END OF SECTION**



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## **SECTION 08 41 13 ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS**

### **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 requirements including but not limited to:
  - 1. Exterior storefront framing.
  - 2. Accessories necessary for a complete installation.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Aluminum framed systems shall withstand the effects of specified performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
  - 1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
  - 2. Dimensional tolerances of building frame and other adjacent construction.
  - 3. Failure includes the following:
    - a. Deflection exceeding specified limits.
    - b. Thermal stresses transferring to building structure.
    - c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
    - d. Noise or vibration created by wind and by thermal and structural movements.
    - e. Loosening or weakening of fasteners, attachments, and other components.
    - f. Sealant failure.
    - g. Failure of operating units.
- B. Structural Loads:
  - 1. Wind Loads: Ultimate Wind Speed Gust; 115 mph. Exposure; D.
- C. Deflection of Framing Members:
  - 1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane shall not exceed  $L/175$  of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to  $3/4$  inch 19 mm, whichever is less.
  - 2. Deflection Parallel to Glazing Plane: Limited to  $L/360$  of clear span or  $1/8$  inch 3.2 mm, whichever is smaller.
- D. Structural Test Performance - Provide aluminum framed systems tested according to ASTM E 330 as follows:
  - 1. When tested at positive and negative wind load design pressures, systems do not evidence deflection exceeding specified limits.
  - 2. When tested at 150 percent of positive and negative wind load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
  - 3. Test Durations: As required by design wind velocity, but not fewer than 10 seconds.

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- E. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft./0.03 L/s per sq. m of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft. (300 Pa).
- F. Water Penetration under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
- G. Windborne Debris Impact Resistance:
  - 1. Pass missile impact and cyclic pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 for Wind Zone 4:
    - a. Large Missile Test: For glazed openings located within 30 feet (9.1 m) of grade.
- H. Thermal Movements:
  - 1. Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss:
    - a. Temperature Change (Range): 120 degrees F (67 degrees C, ambient; 180 degrees F/100 degrees C, material surfaces.
    - b. Interior Ambient-Air Temperature: 75 degrees F (24 degrees C).
- I. Condensation Resistance: Provide aluminum framed systems with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 45 when tested according to AAMA 1503.
- J. Thermal Conductance: Provide aluminum framed systems with fixed glazing and framing areas having an average U-factor of not more than 0.57 Btu/sq. ft. x h x degrees F/3.23 W/sq. m x K when tested according to AAMA 1503.

#### 1.4 SUBMITTALS

- A. Product Data: Technical data for each type of product indicated including construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum framed systems.
- B. Shop Drawings:
  - 1. Submit aluminum storefront framing and entrances shop drawings including plans, elevations, sections, full size details, and attachments to other Work:
    - c. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.
    - d. For entrance doors, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.
- C. Entrance Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related Work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
- D. Engineer's calculations of performance requirements.
- E. Maintenance Data: For aluminum framed systems to include in maintenance manuals.

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## 1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Accessibility Requirements:
    - a. California Building Code: CBC Section 11B-404.3 accessible route.
    - b. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).
    - c. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
    - d. CBC Section 11B-309.4 operable parts interior usage.
- B. Installer Qualifications: Installer having minimum 10 years documented experience who is an authorized representative of the manufacturer and is trained and approved for installation of units required.
- C. Engineering Responsibility: Prepare data for aluminum framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated.
- D. Product Options:
  - 1. Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in service performance:
    - a. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.
- E. Source Limitations: Obtain aluminum framed entrances from single source from single manufacturer.
- F. Preinstallation Conference: Conduct conference at site.

## 1.6 WARRANTY

- A. Written warranty signed by Manufacturer, Contractor, and Installer in which manufacturer agrees to repair or replace components of aluminum framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including, but not limited to, excessive deflection.
    - b. Noise or vibration caused by thermal movements.
    - c. Water leakage through fixed glazing and framing areas.
    - d. Failure of operating components.
  - 2. Warranty Period: Five years from date of Substantial Completion.
- B. Written warranty signed by manufacturer in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering:
  - 1. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 PRODUCTS

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## 2.1 MATERIALS

- A. Basis of Design: Exterior Aluminum Framed Storefront
  - 1. Kawneer Trifab 451T Framing System, center glazed, thermally broken, impact resistant system, maximum design pressure +/- 45 psf. Subject to compliance with requirements, provide comparable storefront system by one of the following:
    - a. Tubelite, Inc.
    - b. US Aluminum Corporation.
    - c. Vistawall.
    - d. YKK America AP, Inc.
- B. Aluminum:
  - 1. Alloy and temper recommended by manufacturer for type of use and finish indicated:
    - a. Sheet and Plate: ASTM B 209/ASTM B 209M.
    - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221/ASTM B 221M.
    - c. Extruded Structural Pipe and Tubes: ASTM B 429.
    - d. Structural Profiles: ASTM B 308/B 308M.
- C. Framing Members:
  - 1. Extruded aluminum framing members of thickness required and reinforced necessary to support imposed loads:
    - a. Construction: Interior Nonthermal / Exterior Thermal.
    - b. Glazing System: Retained mechanically with gaskets on four sides.
    - c. Glazing Plane: Center.
- D. Accessories:
  - 1. Brackets and Reinforcements: High strength aluminum with nonstaining, nonferrous shims for aligning system components.
  - 2. Fasteners and Accessories:
    - a. Corrosion resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials:
      - 1) Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
      - 2) Reinforce members as required to receive fastener threads.
  - 3. Concealed Flashing: Corrosion resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
  - 4. Framing System Gaskets and Sealants: Recommended by manufacturer for joint type.
- E. Glazing:
  - a. Refer to Section 08 80 00:
  - b. Glazing Gaskets: Compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.
  - c. Spacers and Setting Blocks: Elastomeric type.
- F. Accessories:
  - 1. Joint Sealants: For installation at perimeter of aluminum framed systems, refer to Section 07 92 00.
  - 2. Bituminous Paint: Cold applied, asphalt mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30 mil 0.762 mm thickness per coat.

## 2.2 FABRICATION

- A. Form or extrude aluminum shapes before finishing.

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- B. Framing Members:
  - 1. Fabricate components that, when assembled, have specified characteristics:
    - a. Profiles that are sharp, straight, and free of defects or deformations.
    - b. Accurately fitted joints with ends coped or mitered.
    - c. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
    - d. Physical and thermal isolation of glazing from framing members.
    - e. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
    - f. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing or metal panels.
    - g. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
    - h. Provide sill receptors with end dams at all sill conditions.
- C. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- D. Storefront Framing: Fabricate components for assembly using screw spline system.
- E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

## 2.3 ALUMINUM FINISHES

- A. Class I, Clear Anodic Finish (#14): AA-M10C21A41 / AA-M45C22A41, 0.018 mm or thicker.

## PART 3 EXECUTION

### 3.1 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for aluminum framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

### 3.2 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and conditions affecting performance of the Work. Proceed with installation after correcting unsatisfactory conditions.

### 3.3 INSTALLATION

- A. Comply with aluminum framed storefront manufacturer recommended installation instructions. Coordinate installation with curtain wall work:
  - 1. Do not install damaged components.
  - 2. Fit joints to produce hairline joints free of burrs and distortion.
  - 3. Rigidly secure nonmovement joints.
  - 4. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
  - 5. Seal joints watertight unless otherwise indicated.
- B. Metal Protection:
  - 1. Where aluminum will contact dissimilar metals, protect against galvanic action by

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- painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
- 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
- D. Set continuous sill members and flashing in full sealant bed as specified in Section 079200 to produce weathertight installation.
- E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.
- F. Install glazing specified in Section 08 80 00.
- G. Entrance Doors and Hardware:
  - 1. Install doors to produce smooth operation and tight fit at contact points:
    - a. Field Installed Entrance Door Hardware: Install surface mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
- H. Install perimeter joint sealants as specified in Section 07 92 00 to produce weathertight installation.

### 3.4 ERECTION TOLERANCES

- A. Install aluminum framed systems to comply with the following maximum erection tolerances:
  - 1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/4 inch (6 mm) over total length.
  - 2. Alignment:
    - a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch 1.5 mm.
    - b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch 0.8 mm.
- B. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch 3 mm.

### 3.5 ADJUSTING

- A. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer:
  - 1. Door closing speed shall be as follows: CBC Section 11B-404.2.8
    - a. Closer shall be adjusted so that the required time to move a door from an open position of 90 degrees to a position of 12 degrees from the latch is 5 seconds minimum.

### 3.6 MAINTENANCE SERVICE

**END OF SECTION 08 41 13**

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## **SECTION 08 62 23 TUBULAR SKYLIGHTS**

### **PART 1 GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Tubular daylighting devices and accessories.

#### **1.2 RELATED SECTIONS**

- A. Section 06 10 00 – Rough Carpentry; Site built wood curbs and nailers.
- B. Section 07 60 00 - Flashing and Sheet Metal: Metal curb flashings.
- C. Section 08 60 00 - Unit Skylights: Skylights without reflective tube.
- D. Section 26 05 00 - Common Work Results Electrical: Power cable, power supply and electrical connections.

#### **1.3 REFERENCES**

- A. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- B. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- C. ASTM A 463/A 463M - Standard Specification for Steel Sheet, Aluminum Coated, by the Hot Dip Process.
- D. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc Coated (Galvanized), by the Hot Dip Process.
- E. ASTM A 792/A 792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- F. ASTM E 108 - Standard Test Methods for Fire Tests of Roof Coverings.
- G. ASTM E 283 - Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- H. ASTM E 308 - Standard Practice for Computing the Colors of Objects by Using the CIE System.
- I. ASTM E 330 - Structural Performance of Exterior Windows, Curtain Walls and Doors.
- J. ASTM E 547 - Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain walls by Cyclic Air Pressure Difference.
- K. ASTM E 1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.
- L. ASTM E 1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricane.
- M. ASTM D 635 - Test Method for Rate of Burning and/or Extent of Time of Burning of Self-Supporting Plastics in a Horizontal Position.



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- N. ASTM D 1929 - Test Method for Ignition Properties of Plastics.
- O. ASTM D 2843 - Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics.
- P. ASTM F 1642 - Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loading.
- Q. ASTM F 2912 - Standard Specification for Glazing and Glazing Systems Subject to Airblast Loading.
- R. AAMA/WDMA/CSA 101/I.S.2/A440 - Standard/Specification for Windows, Doors, and Unit Skylights; 2011
- S. FM Standard 4431 - The Approval Standard for Skylights
- T. FEMA P-361 - Safe Rooms for Tornadoes and Hurricanes.
- U. ICC 500 - Standard for the Design and Construction of Storm Shelters.
- V. UL 2108 - Low Voltage Lighting Systems
- W. GSA-TS01-2003: Standard Test Method for Glazing and Window Systems Subject to Dynamic Overpressure Loadings
- X. Unified Facilities Criteria (UFC) 4-010-01, Change October 2013, DoD Minimum Antiterrorism Standards for Buildings,
- Y. CSA C22.2 No. 250.0 - Luminaires.
- Z. ICC-ES AC-16 - Acceptance Criteria for Plastic Skylights; 2008.
- AA. Florida Building Code TAS 201 - Impact Test Procedures.
- BB. Florida Building Code TAS 202 - Criteria for Testing Impact and Non Impact Resistant Building Envelope Components Using Uniform Static Air Pressure Loading.
- CC. Florida Building Code TAS 203 - Criteria for Testing Products Subject to Cyclic Wind Pressure Loading
- DD. IBC Section 1710 - Load Test Procedure for Wind Load Testing on Rooftop Daylight Collecting System - Structural Performance Testing - Devised by ATI PE); 2012
- EE. IBC Section 2606.7.2 - Installation - Diffuser Fall Out Test (Devised by PE); 2012
- FF. OSHA 29 CFR - 1910.23 (e)(8) (Guarding Requirements for Skylights); 1926 Subpart M (Fall Protection); 1926.501(b)(4)(i); 1926.501(i)(2); 1926.501(b)(4)(ii).
- GG. California State OSHA Fall Protection Code of Regulations, Title 8, Section 3212 (e)(1).

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Daylight Reflective Tubes: Spectralight Infinity with INFRAREDuction Technology combines ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance. Patented spectrally-selective optical surface yields an average total- and specular-reflectance greater than 99.5% percent for the Visible Light spectrum (400 nm to 700 nm) providing maximized visible light transmission and less than 25% reflectance for Infrared (IR) heat wavelengths (750 nm to 2500 nm) for minimized heat transmission, resulting in a spectrally-selective Total Solar Spectrum (250 nm to 2500 nm) reflectance less than 37 percent, as measured



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using a Perkin Elmer Lambda 1050 spectrophotometer with a Universal Reflectance Accessory. Color:  $a^*$  and  $b^*$  (defined by CIE  $L^*a^*b^*$  color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance to ASTM E 308.

- B. SOLAMASTER 300 DS Daylighting System: (Suspended Ceilings)
  - 1. AAMA/WDMA/CSA 101/IS2/A440, Class CW-PG70 size tested 14 inch (356 mm), Type TDDCC.
    - a. Air Infiltration Test: Air infiltration will not exceed 0.30 cfm/sf aperture with a pressure delta of 1.57 psf across the tube when tested in accordance with ASTM E 283.
    - b. Water Resistance Test:
      - 1) Passes water resistance; no uncontrolled water leakage with a pressure differential of 10.7 psf (512 Pa) or 15 percent of the design load (whichever is greater) and a water spray rate of 5 gallons/hour/sf for 24 minutes when tested in accordance with ICC-ES AC-16, ASTM E 547 and ASTM E 331.
    - c. Uniform Load Test: All units tested with a safety factor of (3) for positive pressure and (2) for negative pressure, acting normal to plane of roof in accordance with ASTM E 330.
      - 2) No breakage, permanent damage to fasteners, hardware parts, or damage to make system inoperable or cause excessive permanent deflection of any section when tested at a Positive Load of 150 psf (7.18 kPa) or Negative Load of 60 psf (2.87 kPa) in accordance with ICC AC-16 Section A, or Negative Load of 70 psf (3.35 kPa) if tested per ICC AC-16 Section B.
    - d. Fire Testing:
      - 3) When used with the Dome Edge Protection Band, all domes meet fire rating requirements as described in the International Building Code.
      - 4) Self-Ignition Temperature - Greater than 650 degrees F per ASTM D 1929.
      - 5) Smoke Density: Rating no greater than 450 per ASTM E 84 in way intended for use. Classification C.
      - 6) Rate of Burn and/or Extent: Maximum Burning Rate: 2.5 inches/min (62 mm/min) Classification CC-2 per ASTM D 635.
      - 7) Rate of Burn and/or Extent: Maximum Burn Extent: 1 inch (25 mm) Classification CC-1 per ASTM D 635.

## 1.5 SUBMITTALS

- A. Submit under provisions of Section 01 30 00.
- 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. Data sheets showing roof dome assembly, flashing base, reflective tubes, diffuser assembly, and accessories.
  - 4. Installation requirements.
- C. Shop Drawings. Submit shop drawings showing layout, profiles and product components, including rough opening and framing dimensions, anchorage, roof flashings and accessories.
- D. Electrical wiring diagrams and recommendations for power and control wiring.
- E. Verification Samples: As requested by Architect.
- F. Test Reports: Independent testing agency or evaluation service reports verifying compliance

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with specified performance requirements.

## 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Engaged in manufacture of tubular daylighting devices for minimum 20 years.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original containers, dry, undamaged, seals and labels intact.
- B. Store products in manufacturer's unopened packaging until ready for installation.

## 1.8 PROJECT 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.

## 1.9 WARRANTY

- A. Daylighting Device: Manufacturer's standard warranty for 10 years.
- B. Electrical Parts: Manufacturer's standard warranty for 5 years, unless otherwise indicated.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Solatube International, Inc., which is located at: Solatube International 2210 Oak Ridge Way; Vista, CA 92081-8341; Toll Free Tel: 888-765-2882; Tel: (760) 477-1120; Fax: (760) 597-4488; Email: [request info \(commsales@solatube.com\)](mailto:request info (commsales@solatube.com)); Web: <http://www.solatube.com>
- B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

### 2.2 TUBULAR DAYLIGHTING DEVICES

- A. Tubular Daylighting Devices General: Transparent roof-mounted skylight dome and self-flashing curb, reflective tube, and ceiling level diffuser assembly, transferring sunlight to interior spaces; complying with ICC AC-16.
- B. SolaMaster Series: Solatube Model 300 DS: 14 Inch (350 mm) Daylighting System:
  - 1. Model:
    - a. Solatube Model 300 DS-C Closed (Penetrating) Ceiling, AAMA Type TDDCC.
  - 2. Capture Zone:
    - a. Roof Dome Assembly: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube.
      - 1) Acrylic Dome Plus Shock Inner Dome Glazing: Type DAI, Inner Dome is 0.115 inch (2.9 mm) minimum thickness classified as CC1 material. High impact resistant injection molded acrylic required for high velocity wind zones.
      - 2) Tube Ring: Attached to top of base section; 0.090 inch (2.3 mm) nominal thickness injection molded high impact acrylic; to prevent thermal bridging between base flashing and tubing and channel condensed moisture out of tubing.

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- 3) Dome Seal: Polyethylene foam seal, black, 0.13 inch (3.2 mm) thick by 14.62 (371 mm) diameter, 2 PCF polyethylene foam.
- 4) LightTracker Reflector, made of aluminum sheet, thickness 0.015 inch (0.4 mm) with Spectralight Infinity. Positioned in the dome to capture low angle sunlight.
- b. Dome Options:
  - 5) Dome Edge Protection Band: Type PB, for fire rated Class A, B or C roof applications. Aluminized steel nominal thickness of 0.028 inches (0.7 mm).
- c. Flashings:
  - 6) Roof Flashing Base:
    - a) One Piece: One piece, seamless, leak-proof flashing functioning as base support for dome and top of tube. Sheet steel, corrosion resistant conforming to ASTM A 653/A 653M or ASTM A 463/A 463M or ASTM A792/A 792M, 0.028 inch (0.7 mm) plus or minus .006 inch (.015 mm) thick.
      - 1) Base Flat: Flat Type F6, no pitch 6 inches (152 mm) high.
  - 7) Flashing Options:
    - a) Flashing Insulator: Type FI, thermal isolation material for use under flashing. For use with Type F6 Flashing.
    - b) Metal Roof Flashing Kit: Type MR, includes Butyl tape, flashing screws, speed nuts, corner washers and polyurethane sealant. For use with Type F6 Flashing.
    - c) Roof Flashing Turret Extensions: Provide manufacturer's standard extension tubes for applications requiring:
      - 1) Type T48: Additional lengths of 48 inches (1200 mm) extension.
3. Transfer Zone:
  - a. Extension Tubes: Aluminum sheet, thickness 0.015 inch (0.4 mm).
    - 1) Reflective Tubes:
      - a) Reflective Extension Tubes: Type EXX, extension tubes with total length of run as indicated on the Drawings.
      - b) Reflective angle adapter tube (standard top and bottom tubes), providing up to a 30-degree angle adjustment.
      - c) Interior Finish: Spectralight Infinity with INFRAREDuction Technology combining ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance.
    - 2) Tube Options
      - a) Extension Tube Angle Adapter: Provide manufacturer's standard adapters for applications requiring:
        - 1) Type A2 two 0 to 90 degree extension tube angle adapters.
      - b) Wire Suspension Kit: Type E, Use the wire suspension kit when additional bracing to the structure is required.
      - c) Spectralight Infinity SoftLight Extension Tube: Type ES, 24-inch (610 mm) Super-reflective extension tube with structured surface providing precise light spread for enhanced visual comfort. Replaces one standard 24-inch (610 mm) extension tube in the tube assembly.
4. Delivery Zone:
  - a. Ceiling Ring: Injection molded impact resistant acrylic. Nominal thickness is 0.110 inches (2.8 mm).
  - b. Ceiling Ring Seal: Polyethylene foam seal, white, 0.25 inch (6.4 mm) wide by 0.19 inch (4.8 mm) high, 2 PCF polyethylene foam with low-tack pressure sensitive adhesive. Upper glazing: PET GAG plastic with EPDM low density sponge seal to minimize condensation and bug, dirt, and air infiltration per ASTM E283. The nominal thickness is 0.039 inches (0.99 mm).

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- 1) Natural Effect Lens: Type LN.
- c. Diffuser Assemblies for Tubes Penetrating Ceilings: Ceiling mounted box transitioning from round tube to square ceiling assembly, supporting light transmitting surface at bottom termination of tube 23.8 inches by 23.8 inches (605 mm by 605 mm) square frame to fit standard suspended ceiling grids or hard ceilings.
  - 2) Metal Transition Box: Type TM, Round to Square transition box comprised of Spectralight Infinity SoftLight material with structured finish on exposed reflective surface, .015in (0.4mm) thick. Color: a\* and b\* (defined by CIE L\*a\*b\* color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance to ASTM E 308.
  - 3) Lens: Type L1 OptiView Fresnel lens design to maximize light output and diffusion with extruded aluminum frame and EPDM foam seal to minimize condensation and bug, dirt and air infiltration per ASTM E 283. Visible Light Transmission shall be greater than 90 percent at 0.022 inch (0.6 mm) thick. Classified as CC2.
- d. Delivery Zone Options:
  - 4) Local Dimmer Control utilizing a butterfly baffle design of Spectralight Infinity reflective material to minimize shadowing when in use: Provided with dimmer switch and cable.
    - a) Daylight Dimmer: Type D Electro-mechanically actuated daylight valve; for universal input voltages ranging between 90 and 277 V at 50 or 60 Hz; maximum current draw of 50 ma per unit; controlled by low voltage, series Type T02. Provided with dimmer switch and cable.
5. Accessories
  - a. Cable: Type CA, Two conductor, 22 gauge, low voltage cable (500 ft.) for multiple unit DC connections. For use with Daylight Dimmer, Type D, only when aggregate circuit runs do not exceed 200 feet (60.96 m).S300DS-C-DAI-PB-F6-T48-FI-MR-EXX-A2-E-ES-TM-L1-LN-D-CA

## 2.3 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. Suspension Wire: Steel, annealed, galvanized finish, size and type for application and ceiling system requirement.
- C. Sealant: Polyurethane or copolymer based elastomeric sealant as provided or recommended by manufacturer.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Examine openings, substrates, structural support, anchorage, and conditions for compliance with requirements for installation tolerances and other conditions.
- C. If substrate and rough opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.

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- B. Coordinate requirements for power supply, conduit and wiring.
- C. 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 printed instructions.
- B. Coordinate installation with substrates, air and vapor retarders, roof insulation, roofing membrane, and flashing to ensure that each element of the Work performs properly and that finished installation is weather tight.
  - 1. Install flashing to produce weatherproof seal with curb and overlap with roofing system termination at top of curb.
  - 2. Provide thermal isolation when components penetrate or disrupt building insulation. Pack fibrous insulation in rough opening to maintain continuity of thermal barriers.
  - 3. Coordinate attachment and seal of perimeter air and vapor barrier material.
- C. Where metal surfaces of tubular unit skylights will contact incompatible metal or corrosive substrates, including preservative-treated wood, provide permanent separation as recommended by manufacturer
- D. Align device free of warp or twist, maintain dimensional tolerances.
- E. After installation of first unit, field test to determine adequacy of installation. Conduct water test in presence of Owner, Architect, or Contractor, or their designated representative. Correct if needed before proceeding with installation of subsequent units.
- F. Inspect installation to verify secure and proper mounting. Test each fixture to verify operation, control functions, and performance. Correct deficiencies.

### **3.4 CLEANING**

- A. Clean exposed surfaces according to manufacturer's written instructions. Touch up damaged metal coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

### **3.5 PROTECTION**

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

**END OF SECTION 08 63 00**

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## SECTION 08 71 00 DOOR HARDWARE

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Door hardware, including electric hardware.
2. Storefront and entrance door hardware.
3. Gate Hardware.
4. Third-party inspection report for fire-rated door assemblies.
5. Allowance for Best brand cores and keys
6. Battery-powered electronic credential access control locks and panic hardware lever trim.
7. Inpact system frame/door/hardware assembly.
8. Card Access control system.
9. Hold-open closers with fire-alarm interface.
10. Wall or floor-mounted electromagnetic hold-open devices.
11. Power supplies for electric hardware.
12. Low energy door operators plus sensors and actuators.
13. Remote button release hardware.
14. Door position switches.
15. Cabinet locks.
16. Padlocks.
17. Cylinders for doors fabricated with locking hardware.
18. Point-to-point wiring diagrams for electric hardware.
19. Key cabinets.

##### B. Related Divisions:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
2. Division 07 – sealant at exterior thresholds
3. Division 08 – metal doors and frames, interior aluminum frames, wood doors, integrated security systems, specialty doors, storefront and glazed curtainwall systems.
4. Division 10 – operable partitions
5. Division 21 – fire and life safety systems
6. Division 28 – security access systems

##### C. Allowances:

1. Refer to Section 01 21 00. Procure scheduled Best brand temporary and permanent cylinder cores and keys from (Owner's lock shop / Owner's Physical Plant Maintenance Dept). Allow \$45 per core and \$7.50 per key. Owner's agent will purchase the cores and keys directly from Best Access Systems or provide the units from Owner's attic stock.

##### D. Specific Omissions: Hardware for the following is specified or indicated elsewhere.

1. Windows.
2. Cabinets, including open wall shelving and locks.
3. Signs, except where scheduled.
4. Toilet accessories, including grab bars.
5. Rough hardware.

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6. Conduit, junction boxes & wiring.
7. Folding partitions, except cylinders where detailed.
8. Sliding aluminum doors, except cylinders where detailed.
9. Access doors and panels, except cylinders where detailed.
10. Corner Guards.
11. Welded steel gates and supports.

## 1.2 REFERENCES:

- A. Use date of standard in effect as of Bid date.
  1. American National Standards Institute
    - a) ANSI 156.18 – Materials and Finishes.
    - b) ICC/ANSI A117.1 - 1998 – Specifications for making buildings and facilities usable by physically handicapped people. [omit for CA work – not applicable]
  2. BHMA – Builders Hardware Manufacturers Association
  3. 2016 California Building Code
    - a) Chapter 11B – Accessibility To Public Buildings, Public Accommodations, Commercial Buildings and Public Housing
  4. DHI – Door and Hardware Institute
  5. NFPA – National Fire Protection Association
    - a) NFPA 80 – Standard for Fire Doors and Other Opening Protectives.
    - b) NFPA 105 – Smoke and Draft Control Door Assemblies
    - c) NFPA 252 – Fire Tests of Door Assemblies
  6. UL – Underwriters Laboratories
    - a) UL10C – Positive Pressure Fire Tests of Door Assemblies.
    - b) UL 305 – Panic Hardware
  7. WHI – Warnock Hersey Incorporated State of California Building Code
  8. Local, State and National applicable codes
  9. SDI – Steel Door Institute
  10. WI – Woodwork Institute
  11. AWI – Architectural Woodwork Institute
  12. NAAMM – National Association of Architectural Metal Manufacturers
- B. Abbreviations
  1. Manufacturers: see table at 2.1.A of this section
  2. Finishes: see 2.7 of this section.

## 1.3 SUBMITTALS & SUBSTITUTIONS

- A. SUBMITTALS: Submit four paper copies of schedule, and one electronic copy . Only submittals printed one sided will be accepted and reviewed. Organize vertically formatted schedule into "Hardware Sets" with index of doors and headings, indicating complete designations of every item required for each door or opening. Minimum 10pt. font size. Include following information:
  1. Type, style, function, size, quantity and finish of hardware items.
  2. Use BHMA Finish codes per ANSI A156.18.
  3. Name, part number and manufacturer of each item.
  4. Fastenings and other pertinent information.
  5. Location of hardware set coordinated with floor plans and door schedule.



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6. Explanation of abbreviations, symbols, and codes contained in schedule.
  7. Mounting locations for hardware.
  8. Door and frame sizes, materials and degrees of swing.
  9. List of manufacturers used and their nearest representative with address and phone number.
  10. Catalog cuts.
  11. Point-to-point wiring diagrams.
  12. Manufacturer's technical data and installation instructions for electronic hardware.
- B. Bid and submit manufacturer's updated/improved item if scheduled item is discontinued.
  - C. Deviations: Highlight, encircle or otherwise identify deviations from "Schedule of Finish Hardware" on submittal with notations clearly designating those portions as deviating from this section.
  - D. If discrepancy between drawings and scheduled material in this section, bid the more expensive of the two choices, note the discrepancy in the submittal and request direction from Architect for resolution.
  - E. Substitutions per Division 1. Include product data and indicate benefit to the Project. Furnish operating samples on request.
  - F. Furnish as-built/as-installed schedule with closeout documents, including keying schedule, riser and point-to-point wiring diagrams, manufacturers' installation, adjustment and maintenance information, and supplier's final inspection report.

#### 1.4 QUALITY ASSURANCE:

- A. Qualifications:
  1. Hardware supplier: direct factory contract supplier who employs a certified Architectural Hardware Consultant (AHC), available at reasonable times during course of work for project hardware consultation to Owner, Architect and Contractor.
    - a) Responsible for detailing, scheduling and ordering of finish hardware. Detailing implies that the submitted schedule of hardware is correct and complete for the intended function and performance of the openings.
- B. Hardware: Free of defects, blemishes and excessive play. Obtain each kind of hardware (latch and locksets, exit devices, hinges and closers) from one manufacturer.
- C. Exit Doors: Operable from inside with single motion without the use of a key or special knowledge or effort.
- D. Fire-Rated Openings: NFPA 80 compliant. Hardware UL10C (positive pressure) compliant for given type/size opening and degree of label. Provide proper latching hardware, non-flaming door closers, approved-bearing hinges, and resilient seals. Coordinate with wood door section for required intumescent seals. Furnish openings complete.
- E. Furnish hardware items required to complete the work in accordance with specified performance level and design intent, complying with manufacturers' instructions and code requirements.
- F. Pre-Installation Meetings: Initiate and conduct with supplier, installer and related trades, coordinate materials and techniques, and sequence complex hardware items and systems installation. Include manufacturers' representatives of locks, panic hardware and door closers in the meetings. Convene prior to commencement of related work.



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### 1.5 DELIVERY, STORAGE AND HANDLING:

- A. Delivery: coordinate delivery to appropriate locations (shop or field).
  - 1. Permanent keys and cores: secured delivery direct to Owner's representative.
- B. Acceptance at Site: Items individually packaged in manufacturers' original containers, complete with proper fasteners and related pieces. Clearly mark packages to indicate contents, locations in hardware schedule and door numbers.
- C. Storage: Provide securely locked storage area for hardware, protect from moisture, sunlight, paint, chemicals, dust, excessive heat and cold, etc.

### 1.6 PROJECT CONDITIONS AND COORDINATION:

- A. Where exact types of hardware specified are not adaptable to finished shape or size of members requiring hardware, provide suitable types having as nearly as practical the same operation and quality as type specified, subject to Architect's approval.
- B. Coordination: Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements indicated, as necessary for proper installation and function, regardless of omissions or conflicts in the information on the Contract Documents. Furnish related trades with the following information:
  - 1. Location of embedded and attached items to concrete.
  - 2. Location of wall-mounted hardware, including wall stops.
  - 3. Location of finish floor materials and floor-mounted hardware.
  - 4. At masonry construction, coordinate with the anchoring and hollow metal supplier prior to frame installation by placing a strip of insulation, wood, or foam, on the back of the hollow metal frame behind the rabbet section for continuous hinges, as well as at rim panic hardware strike locations, silencers, coordinators, and door closer arm locations. When the frame is grouted in place, the backing will allow drilling and tapping without dulling or breaking the installer's bits.
  - 5. Locations for conduit and raceways as needed for electrical, electronic and electro-pneumatic hardware items. Fire/life-safety system interfacing. Point-to-point wiring diagrams plus riser diagrams to related trades.
  - 6. Coordinate: low-voltage power supply locations.
  - 7. Coordinate: back-up power for doors with automatic operators.
  - 8. Coordinate: flush top rails of doors at outswinging exteriors, and throughout where adhesive-mounted seals occur.
  - 9. Manufacturers' templates to door and frame fabricators.
- C. Check Shop Drawings for doors and entrances to confirm that adequate provisions will be made for proper hardware installation.
- D. Environmental considerations: segregate unused recyclable paper and paper product packaging, uninstalled metals, and plastics, and have these sent to a recycling center.

### 1.7 WARRANTY

- A. Part of respective manufacturers' regular terms of sale. Provide manufacturers' written warranties.
- B. Include factory order numbers with close-out documents to validate warranty information, required for Owner in making future warranty claims:
- C. Minimum warranties:

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- |    |                                    |   |
|----|------------------------------------|---|
| 1. | Locksets:                          | Three years                                     |
| 2. | Extra Heavy Duty Cylindrical Lock: | Seven Years                                     |
| 3. | Exit Devices:                      | Three years mechanical<br>One year electrical   |
| 4. | Closers:                           | Thirty years mechanical<br>Two years electrical |
| 5. | Hinges:                            | One year  |
| 6. | Other Hardware                     | Two years                                       |

## 1.8 COMMISSIONING

- A. Conduct these tests prior to request for certificate of substantial completion:
1. With installer present, test door hardware operation with climate control system and stairwell pressurization system both at rest and while in full operation.
  2. With installer, access control contractor and electrical contractor present, test electrical, electronic and electro-pneumatic hardware systems for satisfactory operation.
  3. With installer and electrical contractor present, test hardware interfaced with fire/life-safety system for proper operation and release.

## 1.9 REGULATORY REQUIREMENTS

- A. Locate latching hardware between 34 inches to 44 inches above the finished floor, per 2019 California Building Code, Section 11B-404.2.7.
1. Panic hardware: locate between 36 inches to 44 inches above the finished floor.
- B. Handles, pull, latches, locks, other operable parts:
1. Readily openable from egress side with one hand and without tight grasping, tight pinching, or twisting of the wrist to operate. 2019 California Building Code Section 11B-309.4.
  2. Force required to activate the operable parts: 5.0 pounds maximum, per 2019 California Building Code Section 11B-309.4.
- C. Adjust doors to open with not more than 5.0-pounds pressure to open at exterior doors and 5.0-pounds at interior doors. As allowed per 2016 California Building Code Section 11B-404.2.9, local authority may increase the allowable pressure for fire doors to achieve positive latching, but not to exceed 15-pounds.
1. Exception: exterior doors' pressure-to-open may be increased to 8.5-pounds if: at a single location, and one of a bank of eight leafs or fraction of eight, and one leaf of this bank is fitted with a low- or high-energy operator.
- D. Low-energy powered doors: comply with ANSI/BHMA A156.19. Reference: 2016 California Building Code Section 11B-404.2.9, Exception 2.
1. Where powered door serves an occupancy of 150 or more, provide back-up battery power or stand-by generator power, capable of supporting a minimum of 100 cycles.
  2. Actuators, vertical bar type: minimum 2-inches wide, 30-inches high, bottom located minimum 5-inches above floor or ground, top located minimum 35-inches above floor or ground. Displays International Symbol of Accessibility, per 2019 California Building Code Section 11B-703.7.

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3. Actuators, plate type: use two at each side of the opening. Minimum 4-inches diameter or 4-inches square. Displays International Symbol of Accessibility, per 2019 California Building Code Section 11B-703.7. Locate centerline of lower plate between 7- and 8-inches above floor or ground, and upper plate between 30- and 44-inches above floor or ground.
4. Actuator location: conspicuously located, clear and level floor/ground space for forward or parallel approach.
- E. Adjust door closer sweep periods so that from an open position of 90 degrees, the door will take at least 5 seconds to move to a point 12 degrees from the latch, measured to the landing side of the door, per 2019 California Building Code Section 11B-404.2.8.
  1. Spring hinges: adjust for 1.5 seconds minimum for 70 degrees to fully-closed.
- F. Smooth surfaces at bottom 10 inches of push sides of doors, facilitating push-open with wheelchair footrests, per 2016 California Building Code Section 11B-404.2.10.
  1. Applied kickplates and armor plates: bevel the left and right edges; free of sharp or abrasive edges.
  2. Tempered glass doors without stiles: bottom rail may be less than 10 inches if top leading edge is tapered 60 degrees minimum.
- G. Door opening clear width no less than 32 inches, measured from face of frame stop, or edge of inactive leaf of pair of doors, to door face with door opened to 90 degrees. Hardware projection not a factor in clear width if located above 30 inches and below 80 inches, and the hardware projects no more than 4 inches. 2019 California Building Code Section 11B-404.2.3.
  1. Exception: In alterations, a projection of 5/8 inch (15.9 mm) maximum into the required clear width shall be permitted for the latch side stop.
  2. Door closers and overhead stops: not less than 78 inches above the finished floor or ground, per 2019 California Building Code 11B-307.4.
- H. Thresholds: floor or landing no more than 0.50 inches below the top of the threshold of the doorway, per 2019 California Building Code Section 11B-404.2.5. Vertical rise no more than 0.25 inches, change in level between 0.25 inches and 0.50 inches: beveled to slope no greater than 1:2 (50 percent slope). 2019 California Building Code Section 11B-303.2 & ~.3.
- I. Floor stops: Do not locate in path of travel. Locate no more than 4 inches from walls, per DSA Policy #99-08 (Access).
- J. Pairs of doors with independently-activated hardware both leafs: limit swing of right-hand or right-hand-reverse leaf to 90 degrees to protect persons reading wall-mounted tactile signage, per 2019 California Building Code Section 11B-703.4.2.
- K. Door and door hardware encroachment: when door is swung fully-open into means-of-egress path, the door may not encroach/project more than 7 inches into the required exit width, with the exception of door release hardware such as lockset levers or panic hardware. These hardware items must be located no less than 34-inches and no more than 48-inches above the floor/ground. 2019 California Building Code, Section 1005.7.1.
  1. In I-2 occupancies, latch release hardware is not permitted to project in the required exit width, regardless of its mounting height, per 2019 California Building Code, Section 1005.7.1 at Exception 1.

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## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers and their abbreviations used in this schedule:

BES	Best Locking Systems
GLY	Glynn-Johnson Hardware
IVE	H. B. Ives
LCN	LCN Closers
LUN	Lund
SCE	Schlage Electronics
SCH	Schlage Lock Company
VON	Von Duprin
ZER	Zero International

### 2.2 HINGING METHODS

- A. Drawings typically depict doors at 90 degrees, doors will actually swing to maximum allowable. Use wide-throw conventional or continuous hinges as needed up to 8 inches in width to allow door to stand parallel to wall for true 180-degree opening. Advise architect if 8-inch width is insufficient.
- B. Conform to manufacturer's published hinge selection standard for door dimensions, weight and frequency, and to hinge selection as scheduled. Where manufacturer's standard exceeds the scheduled product, furnish the heavier of the two choices; notify Architect of deviation from scheduled hardware.
- C. Conventional Hinges: Steel or stainless steel pins and approved bearings. Hinge open widths minimum, but of sufficient throw to permit maximum door swing.
  - 1. Outswinging exterior doors: non-ferrous with non-removable (NRP) pins and security studs.
  - 2. Non-ferrous material exteriors and at doors subject to corrosive atmospheric conditions.
- D. Continuous Hinges:
  - 1. Geared-type aluminum.
    - a) Use wide-throw units where needed for maximum degree of swing, advise architect if commonly available hinges are insufficient.
    - b) If units are used at storefront openings, color-coordinate hinge finish with storefront color. Custom anodizing and custom powdercoat finishes subject to Architect approval.
  - 2. Pinned steel/stainless steel type: continuous stainless steel, 0.25-inch diameter stainless-steel hinge pin.
    - a) Use engineered application-specific wide-throw units as needed to provide maximum swing degree of swing; advise architect if required width exceeds 8 inches.
- E. Pivots: high-strength forged bronze or stainless steel, tilt-on precision bearing and bearing pin.
  - 1. Bottom and intermediate pivots: adjustability of minus 0.063 inch, plus 0.125 inch.
- F. Floor Closers: hydraulically controlled, cement case, maximum degree dead stop permitted by trim or adjacent structure. Special pins, floor pans and longer spindles when needed to accommodate floor and jamb conditions.

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## 2.3 LOCKSETS, LATCHSETS, DEADBOLTS:

### A. Mortise Locksets and Latchsets: as scheduled.

1. Chassis: cold-rolled steel, handing field-changeable without disassembly.
2. Universal lock case – 10 functions in one case.
3. Floating mounting tabs automatically adjusts to fit a beveled door edge.
4. Latchbolts: 0.75 inch throw stainless steel anti-friction type.
5. Lever Trim: through-bolted, accessible design, cast lever or solid extruded bar type levers as scheduled. Filled hollow tube design unacceptable.
  - a) Spindles: security design independent breakaway. Breakage of outside lever does not allow access to inside lever's hubworks to gain wrongful entry.
  - b) Inside lever applied by screwless shank mounting – no exposed trim mount screws.
  - c) Levers rotate up or down for ease of use.
  - d) Vandalgard locks: locked lever freely rotates down while remaining securely locked. This feature prevents damage to internal lock components when subjected to excessive force.
6. Furnish solid cylinder collars with wave springs. Wall of collar to cover rim of mortise cylinder.
7. Turnpieces: accessible offset turn-lever design not requiring pinching or twisting motions to operate.
8. Deadbolts: stainless steel 1-inch throw.
9. Electric operation: Manufacturer-installed continuous duty solenoid.
10. Strikes: 16 gage curved steel, bronze or brass with 1 inch deep box construction, lips of sufficient length to clear trim and protect clothing.
11. Scheduled Lock Series and Design: Schlage L series, 06A design.
12. Certifications:
  - a) ANSI A156.13, 1994, Grade 1 Operational, Grade 1 Security.
  - b) ANSI/ASTM F476-84 Grade 31 UL Listed.
13. Accessibility: Require not more than 5 lb to retract the latchbolt or deadbolt, or both, per CBC 2019 11B-404.2.7 and 11B-309.4.

## 2.4 EXIT DEVICES / PANIC HARDWARE

### A. General features:

1. Independent lab-tested 1,000,000 cycles.
2. Push-through push-pad design. No exposed push-pad fasteners, no exposed cavities when operated. Return stroke fluid dampeners and rubber bottoming dampeners, plus anti-rattle devices.
3. Deadlocking latchbolts, 0.75 inch projection.
4. End caps: impact-resistant, flush-mounted. No raised edges or lips to catch carts or other equipment.
5. No exposed screws to show through glass doors.
6. Non-handed basic device design with center case interchangeable with all functions, no extra parts required to effect change of function.
7. Releasable in normal operation with 15-pound maximum operating force per UBC Standard 10-4, and with 32-pound maximum pressure under 250-pound load to the door.
8. Exterior doors scheduled with XP-series devices: Static load force resistance of at least 2000 pounds.
9. Accessibility: Require not more than 5 lb to retract the latchbolt, per CBC 2019 11B-404.2.7 and 11B-309.4.

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- a) Mechanical method: Von Duprin "AX-" feature, where touchpad directly retracts the latchbolt with 5 lb or less of force. Provide testing lab certification confirming that the mechanical device is independent third-party tested to meet this 5 lb requirement.
- b) Electrical method: Von Duprin's "RX-QEL-", where lightly pressing the touchpad with 5 lb or less of force closes an electric switch, activating quiet electric latch retraction.

B. Specific features:

- 1. Non-Fire Rated Devices: cylinder dogging.
- 2. Lever Trim: breakaway type, forged brass or bronze escutcheon min. 0.130 inch thickness, compression spring drive, match lockset lever design.
- 3. Rod and latch guards with sloped full-width kickplates for doors fitted with surface vertical rod devices with bottom latches.
- 4. Fire-Labeled Devices: UL label indicating "Fire Exit Hardware". Vertical rod devices less bottom rod (LBR) unless otherwise scheduled.
- 5. Impact recessed devices: 1.25 inch projection when push-pad is depressed. Sloped metal end caps to deflect carts, etc. No pinch points to catch skin between touchbar and door.
- 6. Delayed Egress Devices: Function achieved within single exit device component, including latch, delayed locking device, request-to-exit switch, nuisance alarm, remote alarm, key switch, indicator lamp, relay, internal horn, door position input, external inhibit input plus fire alarm input. NFPA 101 "Special Locking Arrangement" compliant.
- 7. Electrically Operated Devices: Single manufacturer source for electric latch retraction devices, electrically controlled trim, power transfers, power supplies, monitoring switches and controls.
- 8. Removable Mullions: Removable with single turn of building key. Securely reinstalled without need for key. Furnish storage brackets for securely stowing the mullion away from the door when removed.

## 2.6 CLOSERS

C. Surface Closers:

- 1. Full rack-and-pinion type cylinder with removable non-ferrous cover and cast iron body. Double heat-treated pinion shaft, single piece forged piston, chrome-silicon steel spring.
- 2. ISO 2000 certified. Units stamped with date-of-manufacture code.
- 3. Independent lab-tested 10,000,000 cycles.
- 4. Non-sized, non-handed, and adjustable. Place closer inside building, stairs, and rooms.
- 5. Plates, brackets and special templating when needed for interface with particular header, door and wall conditions and neighboring hardware.
- 6. Adjust doors to open with not more than 5.0-pounds pressure to open at exterior doors and 5.0-pounds at interior doors. As allowed per 2019 California Building Code Section 11B-404.2.9, local authority may increase the allowable pressure for fire doors to achieve positive latching, but not to exceed 15-pounds.
  - a) Exception: exterior doors' pressure-to-open may be increased to 8.5-pounds if: at a single location, and one of a bank of eight leaves or fraction of eight, and one leaf of this bank is fitted with a low- or high-energy operator.
- 7. Separate adjusting valves for closing speed, latching speed and backcheck, fourth valve for delayed action where scheduled.
- 8. Extra-duty arms (EDA) at exterior doors scheduled with parallel arm units.
- 9. Exterior door closers: tested to 100 hours of ASTM B117 salt spray test, furnish data on request.



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10. Exterior doors: seasonal adjustments not required for temperatures from 120 degrees F to -30 degrees F, furnish checking fluid data on request.
11. Non-flaming fluid, will not fuel door or floor covering fires.
12. Pressure Relief Valves (PRV) not permitted. Note: Norton 7500 includes PRV only with their delayed-action cylinders.

## 2.7 OTHER HARDWARE

- A. Automatic Flush Bolts: Low operating force design.
- B. Overhead Stops: Non-plastic mechanisms and finished metal end caps. Field-changeable hold-open, friction and stop-only functions.
- C. Kick Plates: Four beveled edges, .050 inches minimum thickness, height and width as scheduled. Sheet-metal screws of bronze or stainless steel to match other hardware.
- D. Door Stops: Provide stops to protect walls, casework or other hardware.
  1. Unless otherwise noted in Hardware Sets, provide floor type with appropriate fasteners. Where floor type cannot be used, provide wall type. If neither can be used, provide overhead type.
  2. Locate overhead stops for maximum possible opening. Consult with Owner for furniture locations. Minimum: 90deg stop / 95deg deadstop. Note degree of opening in submittal.
- E. Sound-reducing adjustable seals: coordinate lockset backsets, rim exit device strikes, and parallel arm closers. Fabricate 7ga "Z"-brackets as bridging pieces to facilitate installation. Brackets: mild carbon steel, or stainless steel.
- F. Automatic door bottoms: low operating force units. Doors with automatic door bottoms plus head and jamb seals cannot require more than two pounds operating force to open when closer is disconnected.
  1. Include automatic type door bottoms, as opposed to fixed sweeps, at stairs and elevator lobbies to allow fine-tuning of pressurization systems.
- G. Thresholds: As scheduled and per details. Comply with CBC 2019 11B-404.2.5. Substitute products: certify that the products equal or exceed specified material's thickness. Proposed substitutions: submit for approval.
  1. Saddle thresholds: 0.125 inches minimum thickness.
  2. Exteriors: Seal perimeter to exclude water and vermin. Use sealant complying with requirements in Division 7 "Thermal and Moisture Protection". Minimum 0.25 inch diameter fasteners and lead expansion shield anchors, or Red-Head #SFS-1420 (or approved equivalent) Flat Head Sleeve Anchors. Zero International's #226, National Guard Products' "COMBO" or Pemko Manufacturing's "FHSL".
  3. Fire-rated openings, 90-minutes or less duration: use thresholds to interrupt floor covering material under the door where that material has a critical radiant flux value less than 0.22 watts per square centimeter, per NFPA 253. Use threshold unit as scheduled. If none scheduled, include a 0.25in high 5in wide saddle in the bid, and request direction from Architect.
  4. Fire-rated openings, 3-hour duration: Thresholds, where scheduled, to extend full jamb depth.
  5. Acoustic openings: Set units in full bed of Division-7-compliant, leave no air space between threshold and substrate.
  6. Plastic plugs with wood or sheet metal screws are not an acceptable substitute for specified fastening methods.

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7. Fasteners: Generally, exposed screws to be Phillips or Robertson drive. Pinned TORX drive at high security areas. Flat head sleeve anchors (FHSL) may be slotted drive. Sheet metal and wood screws: full-thread. Sleeve nuts: full length to prevent door compression.
- H. Silencers: Interior hollow metal frames, 3 for single doors, 2 for pairs of doors. Leave no unfilled/uncovered pre-punched silencer holes. Intent: door bears against silencers, seals make minimal contact with minimal compression – only enough to effect a seal.
- I. Key Control Software: Same manufacturer as key cylinders, supply to Owner.

## 2.8 FINISH:

- A. Generally: BHMA 626 Satin Chromium.
  1. Areas using BHMA 626: furnish push-plates, pulls and protection plates of BHMA 630, Satin Stainless Steel, unless otherwise scheduled.
- B. Door closers: factory powder coated to match other hardware, unless otherwise noted.
- C. Finish designators used in appended hardware schedule:

### Finishes

ANSI	US	Description	Base Metal
626	US26D	Satin Chromium Plated Over Nickel	Brass, Bronze
630	US32D	Satin Stainless Steel	Stain. Steel 300 Ser
652	US26D	Satin Chromium Plated Over Nickel	Steel
689	US28	Aluminum Painted	Any
AA		Anodized Aluminum	Aluminum
GRY		Grey	Any
US32D	US32D	Satin Stainless Steel, 300 Series	Stainless Steel

## 2.9 KEYING REQUIREMENTS:

- A. Key System: existing Best Access Systems small format interchangeable core system, procured per Allowances in 1.1.C. Owner's agent will install the cores prior to Substantial Completion. Initiate and conduct meeting(s) with Owner to determine system structure and keybow styles, furnish Owner's written approval of the system; do not order keys or cylinders without written confirmation of actual requirements from the Owner. Owner will order and supply permanent cylinders/cores.
- B. Interchangeable Cores: 7-pin solid brass construction.
- C. Permanent cores: furnish factory-keyed.
- D. Procure scheduled brand temporary cylinder cores and operating and control keys from Manufacture of the locks , Provide Allowance of \$45 per core for Permanent cores, coordinate through Owner's agent and Best for purchase of Permanent cores . No Keys will be needed for these Permanent cores, provide Allowance for a Pack of 100 HID Corp 1000 Fobs ,coordinate through Owner's agent and HID for purchase of Fobs.



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## PART 3 - EXECUTION

### 3.1 ACCEPTABLE INSTALLERS:

- A. Can read and understand manufacturers' templates, suppliers' hardware schedule and printed installation instructions. Can readily distinguish drywall screws from manufacturers' furnished fasteners. Available to meet with manufacturers' representatives and related trades to discuss installation of hardware.

### 3.2 PREPARATION:

- A. Ensure that walls and frames are square and plumb before hardware installation. Make corrections before commencing hardware installation. Installation denotes acceptance of wall/frame condition.
- A. Locate hardware per SDI-100 and applicable building, fire, life-safety, accessibility, and security codes.
  - 1. Notify Architect of code conflicts before ordering material.
  - 1. Locate latching hardware between 34 inches to 44 inches above the finished floor, per California Building Code, Section 1008.1.9.2 and 1133B.2.5.2.
  - 2. Locate panic hardware between 36 inches to 44 inches above the finished floor.
  - 3. Where new hardware is to be installed near existing doors/hardware scheduled to remain, match locations of existing hardware.
- B. Overhead stops: before installing, determine proposed locations of furniture items, fixtures, and other items to be protected by the overhead stop's action.

### 3.3 INSTALLATION

- A. Install hardware per manufacturer's instructions and recommendations and approved submittals. Do not install surface-mounted items until finishes have been completed on substrate. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate for proper installation and operation. Remove and reinstall or replace work deemed defective by Architect.
  - 1. Gaskets: install jamb-applied gaskets before closers, overhead stops, rim strikes, etc; fasten hardware over and through these seals. Install sweeps across bottoms of doors before astragals, cope sweeps around bottom pivots, trim astragals to tops of sweeps.
  - 2. When hardware is to be attached to existing metal surface and insufficient reinforcement exists, use RivNuts, NutSerts or similar anchoring device for screws.
  - 3. Use manufacturers' fasteners furnished with hardware items, or submit Request for Substitution with Architect.
  - 4. Replace fasteners damaged by power-driven tools.
- B. Locate floor stops no more than 4 inches from walls and not within paths of travel. See paragraph 2.2 regarding hinge widths. Door shall be well clear of point of wall reveal. Point of door contact no closer to the hinge edge than half the door width. Where situation is questionable or difficult, contact Architect for direction.
- C. Core concrete for exterior door stop anchors. Set anchors in approved non-shrink grout.
- D. Locate overhead stops for minimum 90 degrees at rest and for maximum allowable degree of swing.
- E. Drill pilot holes for fasteners in wood doors and/or frames.
- F. Lubricate and adjust existing hardware scheduled to remain. Carefully remove and give to Owner items not scheduled for reuse.

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### 3.4. ADJUSTING

- A. Adjust and check for proper operation and function. Replace units, which cannot be adjusted to operate freely and smoothly.
  - 1. Hardware damaged by improper installation or adjustment methods: repair or replace to Owner's satisfaction.
  - 2. Adjust doors to fully latch with no more than 1 pound of pressure.
    - a) Door closer valves: turn valves clockwise until at bottom – do not force. Turn valves back out one and one-half turns and begin adjustment process from that point. Do not force valves beyond three full turns counterclockwise.
  - 3. Adjust delayed-action closers on fire-rated doors to fully close from fully-opened position in no more than 10 seconds.
  - 4. Adjust door closers per paragraph 1.9 this section.
- B. Inspection of fire door assemblies and means-of-egress panic-hardware doors: Per 2016 NFPA-80 5.2.1: hire an independent third-party inspection service to prepare a report listing these doors, and include a statement that there are zero deficiencies with the fire-rated assemblies and the openings with panic hardware. Certification, Testing and Quality Control shall be in accordance with Section 01 40 00 Quality Requirements. All doors hardware and installation will be inspected by a third party selected by the Architect and owner  
Div 01 45 23:
  - 1. Per 2016 NFPA-80 5.2.1: Use a third party inspector not associated with the construction, supply or installation of this project to develop a field survey of the doors and hardware. Survey is to be done by a member certified as a FDAI (Fire Door Assembly Inspector), Certified AHC (Architectural Hardware Consultant) or a certified testing laboratory: UL or Intertek. Certified Inspectors may be found at DHI.org, Intertek, or CAFDI.org. J
- C. Fire-rated doors:
  - 1. Wood doors: adjust to 0.125 inches clearance at heads, jambs, and meeting stiles.
  - 2. Steel doors: adjust to 0.063 inches minimum to 0.188 inches maximum clearance at heads, jambs, and meeting stiles.
  - 3. Adjust wood and steel doors to 0.75 inches maximum clearance (undercut) above threshold or finish floor material under door.
- D. Final inspection: Installer to provide letter to Owner that upon completion installer has visited the Project and has accomplished the following:
  - 1. Has re-adjusted hardware.
  - 2. Has evaluated maintenance procedures and recommend changes or additions, and instructed Owner's personnel.
  - 3. Has identified items that have deteriorated or failed.
  - 4. Has submitted written report identifying problems.

### 3.5 DEMONSTRATION:

- A. Demonstrate mechanical hardware and electrical, electronic and pneumatic hardware systems, including adjustment and maintenance procedures.

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### 3.6 PROTECTION/CLEANING:

- A. Cover installed hardware, protect from paint, cleaning agents, weathering, carts/barrows, etc. Remove covering materials and clean hardware just prior to substantial completion.
- B. Clean adjacent wall, frame and door surfaces soiled from installation / reinstallation process.

### 3.7 SCHEDULE OF FINISH HARDWARE

- A. See door schedule in Drawings for hardware set assignments.
- B. Do not order material until submittal has been reviewed, stamped, and signed by Architect's door hardware consultant and Architect as "approved".

#### HARDWARE GROUP NO. 01

For use on Door #(s):

914-A

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
2	EA	POWER TRANSFER	EPT10	✓ 689	VON
1	EA	CORE (COMBINATED)	1C72	626	BES
1	EA	ELEC PANIC HARDWARE	QEL-9847-EO-CON 24 VDC	✓ 626	VON
1	EA	ELEC PANIC HARDWARE	QEL-9847-NL-OP-110MD-CON 24 VDC	✓ 626	VON
1	EA	SFIC RIM CYLINDER	80-159	626	SCH
1	EA	CONSTRUCTION CORE	1C7-GREEN	626	BES
2	EA	90 DEG OFFSET PULL	8190EZHD 10" O	630-316	IVE
2	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	328AA-S	AA	ZER
1	EA	THRESHOLD	THRESHOLD AS DETAILED		
2	EA	DOOR SWEEP	39A	A	ZER
1			CARD READER - WORK OF DIVISION 28		
1			POWER SUPPLY - WORK OF DIVISION 28		

ALL ELECTRIFIED ACCESS CONTROL LOCK HARDWARE, ELECTRIFIED EXIT DEVICES, TRANSFER HINGES, AND MANUFACTURER RECOMMENDED POWER SUPPLIES TO BE SUPPLIED BY SECURITY CONTRACTOR. HARDWARE IS SHOWN FOR TEMPLATING PURPOSES ONLY.

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## HARDWARE GROUP NO. 01A

For use on Door #(s):

917

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112HD EPT	US28	IVE
2	EA	POWER TRANSFER	EPT10	✓ 689	VON
1	EA	CORE (COMBINATED)	1C72	626	BES
1	EA	ELEC PANIC HARDWARE	QEL-9847-EO-CON 24 VDC	✓ 626	VON
1	EA	ELEC PANIC HARDWARE	QEL-9847-NL-OP-110MD-CON 24 VDC	✓ 626	VON
1	EA	SFIC RIM CYLINDER	80-159	626	SCH
1	EA	CONSTRUCTION CORE	1C7-GREEN	626	BES
2	EA	90 DEG OFFSET PULL	8190EZHD 10" O	630-316	IVE
1	EA	SURF. AUTO OPERATOR	9550 SERIES	✓ ANCLR	LCN
2	EA	ACTUATOR, TOUCHLESS	8310-813 WAVE SENSOR	✓ BLK	LCN
2	EA	ACTUATOR	8310-836T	✓ 630	LCN
1	EA	THRESHOLD	THRESHOLD AS DETAILED		
2	EA	DOOR SWEEP	39A	A	ZER
1			CARD READER - WORK OF DIVISION 28		
1			POWER SUPPLY - WORK OF DIVISION 28		

ALL ELECTRIFIED ACCESS CONTROL LOCK HARDWARE, ELECTRIFIED EXIT DEVICES, TRANSFER HINGES, AND MANUFACTURER RECOMMENDED POWER SUPPLIES TO BE SUPPLIED BY SECURITY CONTRACTOR. HARDWARE IS SHOWN FOR TEMPLATING PURPOSES ONLY.

PERIMETER SEALS BY DOOR/FRAME MANUFACTURER

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#### HARDWARE GROUP NO. 01B

For use on Door #(s):

931-A

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112HD EPT	US28	IVE
2	EA	POWER TRANSFER	EPT10	✓ 689	VON
1	EA	CORE (COMBINATED)	1C72	626	BES
1	EA	ELEC PANIC HARDWARE	QEL-9847-EO-CON 24 VDC	✓ 626	VON
1	EA	ELEC PANIC HARDWARE	QEL-9847-L-06-CON 24 VDC	✓ 626	VON
1	EA	SFIC RIM CYLINDER	80-159	626	SCH
1	EA	CONSTRUCTION CORE	1C7-GREEN	626	BES
2	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	328AA-S	AA	ZER
1	EA	THRESHOLD	THRESHOLD AS DETAILED		
2	EA	DOOR SWEEP	39A	A	ZER
1			CARD READER - WORK OF DIVISION 28		
1			POWER SUPPLY - WORK OF DIVISION 28		

ALL ELECTRIFIED ACCESS CONTROL LOCK HARDWARE, ELECTRIFIED EXIT DEVICES, TRANSFER HINGES, AND MANUFACTURER RECOMMENDED POWER SUPPLIES TO BE SUPPLIED BY SECURITY CONTRACTOR. HARDWARE IS SHOWN FOR TEMPLATING PURPOSES ONLY.

#### HARDWARE GROUP NO. 02

For use on Door #(s):

914-B

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 CON TW4	✓ 652	IVE
1	EA	CORE (COMBINATED)	1C72	626	BES
1	EA	EU MORTISE LOCK	L9092BDCEU 06A RX DPS CON 12/24 VDC	✓ 626	SCH
1	EA	CONSTRUCTION CORE	1C7-GREEN	626	BES
1	EA	SURFACE CLOSER	4040XP HCUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
3	EA	SILENCER	SR64	GRY	IVE
1			CARD READER - WORK OF DIVISION 28		
1			POWER SUPPLY - WORK OF DIVISION 28		

ALL ELECTRIFIED ACCESS CONTROL LOCK HARDWARE, ELECTRIFIED EXIT DEVICES, TRANSFER HINGES, AND MANUFACTURER RECOMMENDED POWER SUPPLIES TO BE SUPPLIED BY SECURITY CONTRACTOR. HARDWARE IS SHOWN FOR TEMPLATING PURPOSES ONLY.

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## HARDWARE GROUP NO. 03

For use on Door #(s):

919 928

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 CON TW4	✓ 652	IVE
1	EA	CORE (COMBINATED)	1C72	626	BES
1	EA	EU MORTISE LOCK	L9492BDEU 17A L583-363 DM CON 12/24 VDC	✓ 626	SCH
1	EA	CONSTRUCTION CORE	1C7-GREEN	626	BES
1	EA	OCCUPIED/VACANT INDICATOR FOR OUTSIDE OF DOOR	L283-414	626	SCH
1	EA	WALL STOP	WS406/407CVX	626	IVE
1	EA	COAT AND HAT HOOK	571	626	IVE
3	EA	SILENCER	SR64	GRY	IVE
1			CARD READER - WORK OF DIVISION 28		
1			POWER SUPPLY - WORK OF DIVISION 28		

ALL ELECTRIFIED ACCESS CONTROL LOCK HARDWARE, ELECTRIFIED EXIT DEVICES, TRANSFER HINGES, AND MANUFACTURER RECOMMENDED POWER SUPPLIES TO BE SUPPLIED BY SECURITY CONTRACTOR. HARDWARE IS SHOWN FOR TEMPLATING PURPOSES ONLY.

## HARDWARE GROUP NO. 03B

For use on Door #(s):

925

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 CON TW4	✓ 652	IVE
1	EA	CORE (COMBINATED)	1C72	626	BES
1	EA	EU MORTISE LOCK	L9492BDEU 17A L583-363 DM CON 12/24 VDC	✓ 626	SCH
1	EA	CONSTRUCTION CORE	1C7-GREEN	626	BES
1	EA	SURF. AUTO OPERATOR	9540 SERIES	✓ ANCLR	LCN
2	EA	ACTUATOR, TOUCHLESS	8310-813	✓ BLK	LCN
2	EA	ACTUATOR	WAVE SENSOR 8310-836T	✓ 630	LCN
1	EA	WALL STOP	WS406/407CVX	626	IVE
1	EA	COAT AND HAT HOOK	571	626	IVE
3	EA	SILENCER	SR64	GRY	IVE
1			CARD READER - WORK OF DIVISION 28		
1			POWER SUPPLY - WORK OF DIVISION 28		

OPENING TO HAVE FREE EGRESS AT ALL TIMES  
CARD READER TO ACT AS ACTUATOR FOR AFTER HOURS ENTRY  
HEAD IN SYSTEM TO RELEASE EXTERIOR ACTUATOR DURING PROGRAMED TIMES  
INTERIOR ACTUATOR ALWAYS ACTIVE

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## HARDWARE GROUP NO. 04

For use on Door #(s):

916                      920                      921                      933

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 CON TW4	✓ 652	IVE
1	EA	CORE (COMBINATED)	1C72	626	BES
1	EA	EU MORTISE LOCK	L9092BDCEU 06A RX DPS CON 12/24 VDC	✓ 626	SCH
1	EA	CONSTRUCTION CORE	1C7-GREEN	626	BES
1	EA	SURFACE CLOSER	4040XP HCUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	626	IVE
3	EA	SILENCER	SR64	GRY	IVE
1			CARD READER - WORK OF DIVISION 28		
1			POWER SUPPLY - WORK OF DIVISION 28		

ALL ELECTRIFIED ACCESS CONTROL LOCK HARDWARE, ELECTRIFIED EXIT DEVICES, TRANSFER HINGES, AND MANUFACTURER RECOMMENDED POWER SUPPLIES TO BE SUPPLIED BY SECURITY CONTRACTOR. HARDWARE IS SHOWN FOR TEMPLATING PURPOSES ONLY.

## HARDWARE GROUP NO. 04A

For use on Door #(s):

934-A                      937

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 CON TW4	✓ 652	IVE
1	EA	CORE (COMBINATED)	1C72	626	BES
1	EA	EU MORTISE LOCK	L9092BDCEU 06A RX DPS CON 12/24 VDC	✓ 626	SCH
1	EA	CONSTRUCTION CORE	1C7-GREEN	626	BES
1	EA	SURFACE CLOSER	4040XP HCUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	626	IVE
3	EA	SILENCER	SR64	GRY	IVE
1			CARD READER - WORK OF DIVISION 28		
1			POWER SUPPLY - WORK OF DIVISION 28		

ALL ELECTRIFIED ACCESS CONTROL LOCK HARDWARE, ELECTRIFIED EXIT DEVICES, TRANSFER HINGES, AND MANUFACTURER RECOMMENDED POWER SUPPLIES TO BE SUPPLIED BY SECURITY CONTRACTOR. HARDWARE IS SHOWN FOR TEMPLATING PURPOSES ONLY.

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## HARDWARE GROUP NO. 05

For use on Door #(s):

923 924

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112HD EPT	US28	IVE
1	EA	POWER TRANSFER	EPT10	✓ 689	VON
1	EA	CORE (COMBINATED)	1C72	626	BES
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-98-L-NL-06	✓ 626	VON
1	EA	SFIC RIM CYLINDER	80-159	626	SCH
1	EA	CONSTRUCTION CORE	1C7-GREEN	626	BES
1	EA	SURF. AUTO OPERATOR	9540 SERIES	✓ ANCLR	LCN
2	EA	ACTUATOR, TOUCHLESS	8310-813	✓ BLK	LCN
		WAVE SENSOR			
2	EA	ACTUATOR	8310-836T	✓ 630	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	328AA-S	AA	ZER
1	EA	THRESHOLD	THRESHOLD AS DETAILED		
1	EA	DOOR SWEEP	39A	A	ZER
3	EA	SILENCER	SR64	GRY	IVE
1			CARD READER - WORK OF		
			DIVISION 28		
1			POWER SUPPLY - WORK OF		
			DIVISION 28		

ALL ELECTRIFIED ACCESS CONTROL LOCK HARDWARE, ELECTRIFIED EXIT DEVICES, TRANSFER HINGES, AND MANUFACTURER RECOMMENDED POWER SUPPLIES TO BE SUPPLIED BY SECURITY CONTRACTOR. HARDWARE IS SHOWN FOR TEMPLATING PURPOSES ONLY.

OPENING TO HAVE FREE EGRESS AT ALL TIMES

CARD READER TO ACT AS ACTUATOR FOR AFTER HOURS ENTRY

HEAD IN SYSTEM TO RELEASE EXTERIOR ACTUATOR DURING PROGRAMED TIMES

INTERIOR ACTUATOR ALWAYS ACTIVE



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#### HARDWARE GROUP NO. 07

For use on Door #(s):

930

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	112HD EPT	US28	IVE
1	EA	POWER TRANSFER	EPT10	✓ 689	VON
1	EA	CORE (COMBINATED)	1C72	626	BES
1	EA	EU MORTISE LOCK	L9092BDCEU 06A RX DPS CON 12/24 VDC	✓ 626	SCH
1	EA	CONSTRUCTION CORE	1C7-GREEN	626	BES
1	EA	SURFACE CLOSER	4040XP	689	LCN
1	EA	FLOOR STOP	FS18S	BLK	IVE
1	EA	THRESHOLD	THRESHOLD AS DETAILED		
1	EA	DOOR SWEEP	39A	A	ZER
1			CARD READER - WORK OF DIVISION 28		
1			POWER SUPPLY - WORK OF DIVISION 28		

ALL ELECTRIFIED ACCESS CONTROL LOCK HARDWARE, ELECTRIFIED EXIT DEVICES, TRANSFER HINGES, AND MANUFACTURER RECOMMENDED POWER SUPPLIES TO BE SUPPLIED BY SECURITY CONTRACTOR. HARDWARE IS SHOWN FOR TEMPLATING PURPOSES ONLY.

#### HARDWARE GROUP NO. 09

For use on Door #(s):

932

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CORE (COMBINATED)	1C72	626	BES
1	EA	CLASSROOM LOCK	L9070BD 06A	626	SCH
1	EA	SURFACE CLOSER	4040XP	689	LCN
1	EA	WALL STOP	WS406/407CVX	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

#### HARDWARE GROUP NO. 11

For use on Door #(s):

912

915

922

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CORE (COMBINATED)	1C72	626	BES
1	EA	EU MORTISE LOCK	L9092BDCEU 06A RX DPS CON 12/24 VDC	✓ 626	SCH
1	EA	CONSTRUCTION CORE	1C7-GREEN	626	BES
1			CARD READER - WORK OF DIVISION 28		

BALANCE OF EXISTING HARDWARE TO REMAIN

ALL ELECTRIFIED ACCESS CONTROL LOCK HARDWARE, ELECTRIFIED EXIT DEVICES, TRANSFER HINGES, AND MANUFACTURER RECOMMENDED POWER SUPPLIES TO BE SUPPLIED BY SECURITY CONTRACTOR. HARDWARE IS SHOWN FOR TEMPLATING PURPOSES ONLY.

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#### HARDWARE GROUP NO. 11A

For use on Door #(s):

908	909	910	935	936	938
Provide each SGL door(s) with the following:					
QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CORE (COMBINATED)	1C72	626	BES
1	EA	EU MORTISE LOCK	L9092BDCEU 06A RX DPS CON 12/24 VDC	✓ 626	SCH
1	EA	CONSTRUCTION CORE	1C7-GREEN	626	BES
1	EA	SURFACE CLOSER	4040XP HCUSH	689	LCN
1			CARD READER - WORK OF DIVISION 28		

BALANCE OF EXISTING HARDWARE TO REMAIN

ALL ELECTRIFIED ACCESS CONTROL LOCK HARDWARE, ELECTRIFIED EXIT DEVICES, TRANSFER HINGES, AND MANUFACTURER RECOMMENDED POWER SUPPLIES TO BE SUPPLIED BY SECURITY CONTRACTOR. HARDWARE IS SHOWN FOR TEMPLATING PURPOSES ONLY.

#### HARDWARE GROUP NO. 11B

For use on Door #(s):

905

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 CON TW4	✎ 652	IVE
1	EA	CORE (COMBINATED)	1C72	626	BES
1	EA	EU MORTISE LOCK	L9092BDCEU 06A RX DPS CON 12/24 VDC	✎ 626	SCH
1	EA	CONSTRUCTION CORE	1C7-GREEN	626	BES
1			CARD READER - WORK OF DIVISION 28		

BALANCE OF EXISTING HARDWARE TO REMAIN

ALL ELECTRIFIED ACCESS CONTROL LOCK HARDWARE, ELECTRIFIED EXIT DEVICES, TRANSFER HINGES, AND MANUFACTURER RECOMMENDED POWER SUPPLIES TO BE SUPPLIED BY SECURITY CONTRACTOR. HARDWARE IS SHOWN FOR TEMPLATING PURPOSES ONLY.

#### HARDWARE GROUP NO. 12

For use on Door #(s):

929

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	QEL BASEPLATE CONVERSION KIT	958003	✓ AL	VON
1	EA	PA BRKT KIT	PA PBKIT 99 X 3' X US26D	626	VON

BALANCE OF HARDWARE TO REMAIN

ALL ELECTRIFIED ACCESS CONTROL LOCK HARDWARE, ELECTRIFIED EXIT DEVICES, TRANSFER HINGES, AND MANUFACTURER RECOMMENDED POWER SUPPLIES TO BE SUPPLIED BY SECURITY CONTRACTOR. HARDWARE IS SHOWN FOR TEMPLATING PURPOSES ONLY.

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#### HARDWARE GROUP NO. 13

For use on Door #(s):

931-B 934-B

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CORE (COMBINATED)	1C72	626	BES
1	EA	ELEC PANIC HARDWARE	RX-QELX-PA-AX-98-L-NL-06	✓ 626	VON
1	EA	SFIC RIM CYLINDER	80-159	626	SCH
1	EA	CONSTRUCTION CORE	1C7-GREEN	626	BES
1		CARD READER - WORK OF DIVISION 28			

BALANCE OF EXISTING HARDWARE TO REMAIN

ALL ELECTRIFIED ACCESS CONTROL LOCK HARDWARE, ELECTRIFIED EXIT DEVICES, TRANSFER HINGES, AND MANUFACTURER RECOMMENDED POWER SUPPLIES TO BE SUPPLIED BY SECURITY CONTRACTOR. HARDWARE IS SHOWN FOR TEMPLATING PURPOSES ONLY.

#### HARDWARE GROUP NO. 14

For use on Door #(s):

901A 901B

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	QEL BASEPLATE CONVERSION KIT	958003	✓ AL	VON
1	EA	PA BRKT KIT	PA PBKIT 99 X 3' X US26D	626	VON
1		CARD READER - WORK OF DIVISION 28			

EXISTING EL PANIC HARDWARE TO BE RETROFITTED

BALANCE OF EXISTING HARDWARE TO REMAIN

ALL ELECTRIFIED ACCESS CONTROL LOCK HARDWARE, ELECTRIFIED EXIT DEVICES, TRANSFER HINGES, AND MANUFACTURER RECOMMENDED POWER SUPPLIES TO BE SUPPLIED BY SECURITY CONTRACTOR. HARDWARE IS SHOWN FOR TEMPLATING PURPOSES ONLY.

MAINTENANCE MATERIALS: Provide the following as per Sections 01 77 00 and 01 78 23.

- As-built hardware schedule
- Copies of warranty information for each hardware type
  - Include a requirement for factory order numbers, needed by Owner if claim needs to be made.
- Binder of catalog cuts or complete catalog sections of items used, installation and maintenance/adjustment information.
- Collection of tools that were included with the hardware: wrenches, drivers, etc.

END OF SECTION

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## **SECTION 08 80 00 GLAZING**

### **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 requirements including but not limited to:
  - 1. Float glass.
  - 2. Tempered glass.
  - 3. Insulated glass.
  - 4. Glazing sealants.
  - 5. Accessories necessary for a complete installation.

#### **1.3 DEFINITIONS**

- A. Glass Thickness: Indicated by thickness designations in millimeters according to ASTM C 1036.
- B. Interspace: Space between lites of an insulating glass unit.

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Design glass panels including comprehensive engineering analysis by a qualified professional engineer lawfully licensed in the State of California, using performance requirements and design criteria indicated.
- B. Installed Glazing: Design glazing systems to withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- C. Structural Performance:
  - 1. Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the CBC and ASTM E 1300:
    - a. Design Wind Pressures: Indicated on Structural Drawings.
    - b. Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings:
      - 1) Wind Design Data: As indicated on Drawings.
      - 2) Basic Wind Speed: 115 mph.
      - 3) Importance Factor: 1.0.
  - 2. Exposure Category: D.
  - 3. Design Snow Loads: Indicated on Drawings.
  - 4. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.
  - 5. Maximum Lateral Deflection: For glass supported on all four edges, limit center of glass deflection at design wind pressure to not more than 1/50 times the short side length or 1 inch (25 mm), whichever is less.

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- D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- E. Thermal and Optical Performance Properties:
  - 1. Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
    - a. For monolithic glass lites, properties are based on units with lites 6 mm thick.
    - b. For insulating glass units, properties are based on units of thickness indicated for overall unit and for each lite.
    - c. U-Factors: Center of glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
    - d. Solar Heat Gain Coefficient and Visible Transmittance: Center of glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
    - e. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

## 1.5 SUBMITTALS

- A. Product Data: Technical data for each type of product including recommended installation and cleaning procedures.
- B. Glass Samples: For each type of glass required. Prepare samples from same material to be used for Work.
- C. Glazing Schedule: List glass types and thickness for each size opening and location. Use same designations indicated on Drawings.
- D. Delegated Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Product Certificates:
  - 1. Submit glass product certificates required by Code:
    - a. Glass Manufacturer Certificate: The glass manufacturer shall submit a letter certifying it has reviewed the glazing details proposed for the project, including the use of gaskets and sealants, and that each product furnished is recommended for the application shown and compliance with the Code.
- F. Thermal Stress and Wind Load Analyses:
  - 1. Submit the following from the glass manufacturer:
    - a. Thermal stress analysis for each exterior glass unit type, each building elevation. The analysis shall clearly indicate the expected service temperature ranges and the effects of partial and full shading on the glass:
      - 1) Attach to the thermal stress analysis a statement from the glass manufacturer that based upon this analysis that the resulting thermal stresses will not reduce the specified statistical probability of breakage.
  - 2. Wind load analysis for each glass unit type, each building elevation. The analysis shall indicate the statistical probability of breakage at the design wind pressure does not exceed the specified statistical probability of breakage.
- G. Product Test Reports:
  - 1. Submit test reports for insulating glass and glazing sealants, for tests performed by a qualified testing agency:
    - a. Glazing Sealants: Provide test reports based on testing current sealant

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- formulations within previous 36 month period.
- c. Glazing Sealants: Preconstruction adhesion and compatibility test report.

## 1.6 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Comply with applicable requirements of the CBC for glazing.
  2. Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies:
    - a. As a minimum provide Category II materials complying with testing requirements in 16 CFR 1201 (Consumer Product Safety Commission *Safety Standard for Architectural Glazing Materials*, published in the Code of Federal Regulations) and ANSI Z97.1.
    - d. Permanently mark safety glass with certification label of Safety Glazing Certification Council.
  3. Insulating Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
  4. Comply with published recommendations of glass product organizations:
    - a. GANA: Glazing Manual.
    - e. IGMA: SIGMA TM-3000 Vertical Glazing Guidelines.
    - f. GANA: Laminated Glazing Reference Manual.
    - g. AAMA: AAMA GDSG-1 Glass Design for Sloped Glazing.
    - h. AAMA: TIR A7 Sloped Glazing Guidelines.
    - i. IGMA for Sloped Glazing: IGMA TB-3001 Guidelines for Sloped Glazing.
    - j. IGMA for Insulating Glass: SIGMA TM-3000 North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use.
  5. Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated:
    - a. Minimum Glass Thickness for Exterior Lites: 1/4 inch (6 mm).
    - k. Thickness of Tinted Glass: Provide same thickness for each tint color indicated.
  6. Where annealed float glass is indicated, provide annealed float glass, heat strengthened float glass, or fully tempered float glass necessary to comply with performance requirements:
    - a. Where heat strengthened float glass is indicated, provide heat strengthened float glass or fully tempered float glass necessary to comply with performance requirements.
    - l. Where fully tempered float glass is indicated, provide fully tempered float glass.
- B. Manufacturer Qualifications for Insulating Glass Units with Sputter Coated, Low E Coatings: Insulating glass manufacturer who is approved and certified by coated glass manufacturer.
- C. Installer Qualifications, Glazer: Experience entity having minimum 5 years documented experience and who employs glass installers certified under the National Glass Association's Certified Glass Installer Program.
- D. Installer Qualifications, Decorative Film: Experience entity having minimum 5 years documented experience in the installation of glass films.
- E. Source Limitations for Glass and Glass Accessories: Obtain each type of glass and glass accessories from a single source.
- F. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- G. Sealant Testing Agency Qualifications: An independent testing agency qualified according to

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ASTM C 1021 to conduct the testing indicated.

- H. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
- I. Install glazing in mockups specified to match glazing systems required for Project, including glazing methods:
  - 1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- J. Preconstruction Adhesion and Compatibility Testing:
  - 1. Test each glass product, tape sealant, gasket, glazing accessory, and glass framing member for adhesion to and compatibility with elastomeric glazing sealants:
    - a. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
    - m. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
    - n. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
    - o. Schedule enough time for testing and analyzing results to prevent delaying the Work.
    - p. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.
- K. Pre-installation Conference: Conduct conference at site.

## 1.7 WARRANTY

- A. Written warranty, executed by glass manufacturer agreeing to repair or replace **glass** units that fail in materials and workmanship or deteriorate within warranty period. Warranty covers only deterioration due to normal conditions of use and not to handling, installing, and cleaning practices contrary to decorative glass manufacturer's published instructions:
  - 1. Warranty Period: Five (5) years from date of Substantial Completion.
- B. Written warranty signed by manufacturer in which glass manufacturer agrees to replace **coated glass** units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating:
  - 1. Warranty Period: Ten (10) years from date of Substantial Completion.
- C. Written warranty signed by manufacturer in which manufacturer agrees to replace **insulating glass** units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass:
  - 1. Warranty Period: Ten (10) years from date of Substantial Completion.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage



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to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

- B. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by manufacturer.
- D. Exercise exceptional care to prevent edge damage to glass, and damage/deterioration to coating on glass.
- E. Comply with insulating glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Manufacturers are subject to compliance with requirements; provide products by one of the following:
  - 1. Glass:
    - a. PPG Industries
    - b. Cardinal Glass Industries.
    - c. Guardian Industries Corp.
    - d. Pilkington North America.
- B. 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 1300 for design load resistance of glass type, thickness, dimensions and maximum lateral deflection of support 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.
- C. Thermal and Optical Performance: Provide glass 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:
  - 4. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
  - 5. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
  - 6. Solar Optical Properties: Comply with NFRC 300 test method.
- C. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.
- D. Ultraclear Float Glass: ASTM C 1036, Type I, Class I (clear), Quality-Q3.



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- E. Tinted Annealed Float Glass: ASTM C 1036, Type I, Class 2 (tinted), Quality-Q3.
- F. Fully Tempered Float Glass:
  - 1. ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3:
    - a. Fabrication Process: By horizontal (roller hearth) process with roll wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- G. Heat Strengthened Float Glass:
  - 1. ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3:
    - a. Fabrication Process: By horizontal (roller hearth) process with roll wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- H. Pyrolytic Coated, Low Maintenance Glass: Clear float glass with a coating on first surface having both photocatalytic and hydrophilic properties that act to loosen dirt and to cause water to sheet evenly over the glass instead of beading.
  - a) .
- I. Adhered Backing:
  - 1. Adhered scrim backing to ceramic coated surface; provide backed units identical to materials which, while possibly developing cracks and fissures, show no shear nor develop any openings large enough for the unobstructed penetration of 3 inch diameter sphere when tested by approved independent testing laboratory:
    - a. Mount test specimens consisting of 3 glass assemblies, 34" x 76" (plus zero or minus 3/16 inch), for testing as specified in ANSI Z-97.1.
    - q. Expose specimens to 100 cycles of the following conditions:
      - 1) 1 hour at 0 degrees F, ambient humidity.
      - 2) 3 hours increase from 0 degrees F to 140 degrees F, 95 to 100 percent relative humidity.
      - 3) 1 hour at 140 degrees F, 95 to 100 percent relative humidity.
      - 4) 3 hours decrease from 140 degrees F to 0 degrees F, ambient humidity.
    - r. Break glass by springloaded prick punch at midpoint of either vertical edge.
    - s. After breaking glass, subject it to pressure of 4 lbf per sq. ft. for 5 minutes to simulate wind load.
    - t. Inorganic Opacifier: Provide polyethylene opacifier where no insulation and other backing material is applied directly to spandrel glass. Use polyester where direct attachment does occur.
    - u. Fallout Resistance: Provide spandrel units identical to those passing fallout resistance test for spandrel glass specified in ASTM C 1048.
- J. Silicone Coated Spandrel Glass: ASTM C 1048, Type I, Condition C, Quality-Q3.

## 2.2 INSULATING GLASS

- A. Factory assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
- B. Performance Properties:
  - 1. Basis of Design Product: PPG industries, Tint : Solarbronze (warm-bronze)
  - 2. Overall Unit Thickness: 1 inch (25 mm).
  - 3. Minimum Thickness of Each Glass Lite: 1/4 inch (6 mm).
  - 4. Outdoor Lite: Fully tempered float glass.
  - 5. Interspace Content: Air .
  - 6. Indoor Lite: Fully tempered float glass.

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7. Safety glazing required.

C. Sealing System:

1. Dual seal, with polyisobutylene and silicone primary and secondary sealants:
  - a. Spacer: Aluminum with black, color anodic finish. Thermally broken aluminum.
  - v. Manufacturers: Subject to compliance with requirements, provide products by Technoform Glass Insulation NA, Inc.
  - w. Desiccant: Molecular sieve or silica gel, or a blend of both.

## 2.3 GLAZING ACCESSORIES

- A. Compatibility: Provide glazing sealants compatible with one another and with other materials in contact, including glass products, seals of insulating glass units, and glazing channel substrates, under conditions of service and application, demonstrated by sealant manufacturer based on testing and field experience.
- B. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
- C. Colors of Exposed Glazing Sealants: Selected by Architect.
- D. Glazing Sealant - Neutral curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT:
  1. Manufacturers are subject to compliance with requirements; provide products by one of the following:
    - a. Dow Corning Corporation.
    - x. GE Construction Sealants; Momentive Performance Materials Inc.
    - y. May National Associates, Inc.; a subsidiary of Sika Corporation.
    - z. Pecora Corporation.
    - aa. Sika Corporation.
- E. Glazing Sealant - Neutral curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT:
  1. Manufacturers are subject to compliance with requirements; provide products by one of the following:
    - a. BASF Corporation; Construction Systems.
    - bb. Dow Corning Corporation.
    - cc. GE Construction Sealants; Momentive Performance Materials Inc.
    - dd. May National Associates, Inc.; a subsidiary of Sika Corporation.
    - ee. Pecora Corporation.
    - ff. Polymeric Systems, Inc.
    - gg. Sika Corporation.
- F. Glazing Sealant - Neutral curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT:
  1. Manufacturers are subject to compliance with requirements; provide products by one of the following:
    - a. Bostik, Inc.
    - hh. Dow Corning Corporation.
    - ii. GE Construction Sealants; Momentive Performance Materials Inc.
    - jj. May National Associates, Inc.; a subsidiary of Sika Corporation.
    - kk. Polymeric Systems, Inc.
    - ll. Schnee-Morehead, Inc., an ITW company.
    - mm. Sika Corporation.

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- G. Glazing Sealant - Acid curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT:
  - 1. Manufacturers are subject to compliance with requirements; provide products by one of the following:
    - a. BASF Corporation; Construction Systems.
    - nn. Bostik, Inc.
    - oo. Dow Corning Corporation.
    - pp. GE Construction Sealants; Momentive Performance Materials Inc.
    - qq. May National Associates, Inc.; a subsidiary of Sika Corporation.
    - rr. Pecora Corporation.
    - ss. Polymeric Systems, Inc.
    - tt. Schnee-Morehead, Inc., an ITW company.
    - uu. Sika Corporation.
- H. Glazing Sealants for Fire rated Glazing Products - Neutral curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT. Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated:
  - 1. Manufacturers are subject to compliance with requirements; provide products by one of the following:
    - a. Dow Corning Corporation.
    - vv. GE Construction Sealants; Momentive Performance Materials Inc.
  - 2. Colors of Exposed Glazing Sealants: Selected by Architect.
- I. Back Bedding Mastic Glazing Tapes:
  - 1. Preformed, butyl based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
    - a. AAMA 804.3 tape, where indicated.
    - b. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
    - c. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- J. Expanded Cellular Glazing Tapes:
  - 1. Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
    - a. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
    - b. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.
- K. Miscellaneous Glazing Accessories:
  - 1. Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with proven record of compatibility with surfaces contacted in installation:
    - a. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
    - b. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
    - c. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
    - d. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

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- e. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- f. Perimeter Insulation for Fire Resistive Glazing: Product approved by testing agency listed and labeled fire resistant glazing product with which it is used for application and fire protection rating indicated.

## 2.4 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements:
  - 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components:
    - a. Temperature Change: 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C), material surfaces.
  - 2. Edge and Surface Conditions: Comply with the recommendations of AAMA *Structural Properties of Glass* for clean cut edges, except comply with manufacturer's recommendations.
  - 3. Exposed Glass Edges and Surface Condition: Finish edges flat with an arrissed edge profile (small bevel of uniform width not exceeding 1.5 mm at an angle of approximately 45 degrees to the surface of the glass) with polished (surface is reflective in appearance similar to the major surface of the glass) surface.
- B. Cutting: Wheel cut or sawed edges and seamed at manufacturer's option. For site cut glass, provide glass 2 inches (50.8 mm) larger than required in both dimensions to facilitate cutting of clean cut edges without the necessity of seaming or nipping. Do not cut, seam, nip or abrade heat treated glass.
- C. Butt Glazing: Clean cut or flat grind vertical edges of butt glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- D. Edges: Grind smooth and polish exposed glass edges and corners.

## PART 3 EXECUTION

### 3.1 FIELD CONDITIONS

- A. Environmental Limitations:
  - 1. Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes:
    - a. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 degrees F (4.4 degrees C).
- B. Field Measurements: Verify actual dimensions of openings and construction contiguous with decorative glass by field measurements before fabrication.

### 3.2 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

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### 3.3 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
  - 1. Manufacturing and installation tolerances, including size, squareness, and offsets at corners.
  - 2. Presence and functioning of weep systems.
  - 3. Minimum required face and edge clearances.
  - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation after correcting unsatisfactory conditions.

### 3.4 PREPARATION

- A. Clean glazing channels and framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates:
  - 1. Comply with manufacturer instructions for wiping of surfaces immediately before application of primers.
  - 2. Wipe metal surfaces with IPA (isopropyl alcohol) unless otherwise required by compatibility and adhesion testing results.
- B. Inspect each piece of glass immediately before installation. Do not install pieces improperly sized or with damaged edges, scratches, abrasion, or evidence damage. Remove labels from glass immediately after installation.
- C. Examine glazing units to locate exterior and interior surfaces. Label or mark units so exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.
- D. Seal vent (breather or capillary) tubes in insulating glass units in accordance with insulating glass manufacturer written recommendations.

### 3.5 GLAZING

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm):
  - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets

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- and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8 inch (3 mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
  - H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
  - I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
  - J. Where wedge shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement:
    1. Square cut wedge shaped gaskets at corners and install gaskets as recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.
  - K. Tape Glazing:
    1. Position tapes on fixed stops so that, when compressed by glass, the exposed edges are flush with or protrude slightly above sightline of stops:
      - a. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make tapes fit opening.
      - b. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
      - c. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
      - d. Do not remove release paper from tape until right before each glazing unit is installed.
      - e. Apply heel bead of elastomeric sealant.
      - f. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
      - g. Apply cap bead of elastomeric sealant over exposed edge of tape.
  - L. Gasket Glazing (Dry):
    1. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation:
      - a. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
      - b. Installation with Drive in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
      - c. Installation with Pressure Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure glazing stops, applying pressure uniformly to



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compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

- d. Install gaskets to protrude past face of glazing stops.

M. Sealant Glazing (Wet):

1. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance:
  - a. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
  - b. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

N. Erection Tolerances:

1. Maximum Deviation from Vertical: 1/8 inch in any story and 1/4 inch in any 45 foot run.
2. Maximum Deviation from Horizontal: 1/8 inch in any 30 foot run.
3. Maximum Deviation from True Alignment: 1/32 inch for any two (2) abutting units. Allow no edge projections.
4. Maximum Joint Gap: 1/32 inch.

O. Insulating-Glass Unit(s)

1. Double Glazed Tinted Solar Control Insulating Glass Unit Solarban® 60 on Solexia® 6mm (2) | Air 1/2" (12.7mm) | Clear 6mm:
  - a. Conformance: ASTM E 2190
  - b. Outdoor Lite: Solexia® Tinted Float Glass as manufactured by Vitro Architectural Glass:
    - 1) Conformance: ASTM C 1036, Type 1, Class 2, Quality q3.
    - 2) Glass Thickness: 6mm (1/4")
    - 3) Magnetic Sputter Vacuum Deposition Coating (MSVD): ASTM C 1376.
    - 4) Coating: Solarban® 60 on Surface # 2
    - 5) Heat-Treatment: Heat-strengthened, ASTM C 1048, Kind HS, Tempered; ASTM C 1048, Kind FT; Safety Glazing meets ANSI Z97.1 and CPSC 16CFR-1201
  - c. Interspace Content: Air 1/2" (12.7mm)
  - d. Indoor Lite:
    - 1) Clear float glass as manufactured by Vitro Architectural Glass:
      - a) Conformance: ASTM C 1036, Type 1, Class 1, Quality q3.
      - b) Heat-Treatment: [None] [Heat-strengthened, ASTM C 1048, Kind HS] [Tempered; ASTM C 1048, Kind FT; Safety Glazing meets ANSI Z97.1 and CPSC 16CFR-1201]Specifier Notes: Specify the method of heat treatment. Vitro recommends that heat strengthened glass be specified and used, except where tempered glass is mandated for safety or other purposes by code.
      - c) Glass Thickness: 6mm (1/4")
  - e. Performance Requirements:
    - 1) Visible Light Transmittance: 61 percent minimum.
    - 6) Winter Nighttime U-Factor: 0.29 (Btu/hr\*ft<sup>2</sup>\*°F) maximum.
    - 7) Summer daytime U-Factor: 0.27 (Btu/hr\*ft<sup>2</sup>\*°F) maximum.

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- 8) Shading Coefficient: 0.37 maximum.
- 9) Solar Heat Gain Coefficient: 0.32 maximum.
- 10) Outdoor Visible Light Reflectance: 9 percent maximum.

### 3.6 GLAZING SCHEDULE

#### A. GLASS MATERIALS

- 1. Float Glass: Provide float glass based glazing unless noted otherwise.  
annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality-Q3.
  - a. Heat-Strengthened and Fully Tempered Types: ASTM C1048, Kind HS and FT.
  - b. Fully Tempered Safety Glass: Complies with ANSI Z97.1 and 16 CFR 1201 criteria.
  - c. Tinted Type: ASTM C1036, Class 2 - Tinted, Quality-Q3, color and performance characteristics as indicated.
  - d. Thicknesses: As indicated; provide greater thickness as required for exterior glazing wind load design.

#### B. INSULATING GLASS UNITS

- 1. Insulating Glass Units Manufacturers: Basis of design
  - a. PPG Industries, Inc: [www.ppgideascape.com](http://www.ppgideascape.com).
- 2. Insulating Glass Units: Types as indicated.
  - a. Durability: Certified by an independent testing agency to comply with ASTM E2190.
  - b. 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.
  - c. Spacer Color: Aluminum.
  - d. Edge Seal:
  - e. Color: Black.
  - f. Purge interpane space with dry air, hermetically sealed.

#### C. BASIS OF DESIGN - INSULATING GLASS UNITS

- 1. Type: Insulating Glass Units: Vision glazing, with Low-E coating.
  - a. Applications: Exterior insulating glass glazing unless otherwise indicated.
  - b. Space between lites filled with argon.
  - c. Total Thickness: 1 inch.
  - d. Thermal Transmittance (U-Value), Summer - Center of Glass: 0.29, nominal.
  - e. Visible Light Transmittance (VLT): 42 percent, nominal.
  - f. Solar Heat Gain Coefficient (SHGC): 0.32, nominal.
  - g. Glazing Method: Dry glazing method, gasket glazing.
  - h. Basis of Design - PPG Industries, Inc: [www.ppgideascape.com](http://www.ppgideascape.com).
  - i. Outboard Lite: Annealed float glass, 1/4 inch thick, minimum.
    - 1) Tint: Solarbronze (warm-bronze).
  - j. Inboard Lite: Heat-strengthened float glass, 1/4 inch thick.
    - 2) Low-E Coating: PPG Solarban 60 on #3 surface.
    - 3) Tint: Clear.

#### D. BASIS OF DESIGN - INTERIOR GLASS UNITS

- 1. Type: Glass Units: Vision glazing
  - a. Applications: Interior glass glazing unless otherwise indicated.
  - b. Heat-Strengthened and Fully Tempered Types: ASTM C1048, Kind HS and FT.
  - c. Total Thickness: 1/4 inch.



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### **3.7 CLEANING AND PROTECTION**

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains:
  - 1. If contaminating substances come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

## **PART 4 SCHEDULE**

### **4.1 GLAZING SCHEDULE**

- A. G-1 Insulated Glass: 1 inch (25 mm) sealed insulated unit consisting of an exterior lite of 1/4 inch (6 mm) low-e tinted tempered float glass, 1/2 inch gas filled air space, and 1/4 inch (6 mm) clear tempered float glass interior lite.
- B. G-2 Clear Tempered Glass: 1/4 inch (6 mm) clear tempered float glass.

**END OF SECTION 08 80 00**

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## **SECTION 08 81 17 FIRE-RATED GLAZING**

### **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. Fire-rated insulated glass units (IGU) installed as windows in fire-rated frames.
- B. Related Sections include the following:
  - 1. **Section 08 11 13: Hollow Metal Doors and Frames.**
- C. Reference Standards:
  - 1. American Society for Testing and Materials (ASTM):
    - a. ASTM C920: Standard Specification for Elastomeric Joint Sealants.
    - b. ASTM C1036: Standard Specification for Flat Glass.
    - c. ASTM C1048: Standard Specification for Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass.
  - 2. Glass Association of North America (GANA):
    - a. GANA – Glazing Manual.
    - b. FGMA – Sealant Manual.
  - 3. National Fire Protection Association (NFPA):
    - a. NFPA 257 – Fire Tests of Window Assemblies.
  - 4. SIGMA TM-3000-90 – Vertical Glazing Guidelines.
  - 5. Underwriters Laboratories, Inc. (UL):
    - a. UL 9 – Fire Tests of Window Assemblies.
  - 6. Building Code: Comply with applicable requirements of the 2019 CBC for glazing.

#### **1.3 DEFINITIONS**

- A. Manufacturer: A firm that produces primary glass, fabricated glass or framing as defined in referenced glazing publications.

#### **1.4 SUBMITTALS**

- A. Product data: Submit manufacturer's technical data for each glazing material required, including installation and maintenance instructions.
- B. Certificates of compliance from glass and glazing materials manufacturers attesting that glass and glazing materials furnished for project comply with requirements. Separate certification will not be required for glazing materials bearing manufacturer's permanent label designating type and thickness of glass, provided labels represent a quality control program involving a recognized certification agency or independent testing laboratory acceptable to authority having jurisdiction.
- C. Product Test Listings: From UL indicating fire-rated glass complies with requirements, based on comprehensive testing of current product.
- D. Samples: Submit, for verification purposes, approx. 8-inch by 10-inch sample for each type

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of glass indicated.

- E. Insulating Glass Certification Program:
  - 1. Provide insulating glass units complying with requirements indicated which are permanently marked with certification label of the following inspecting and testing agency:
    - a. Insulating Glass Certification Council.
    - b. Associated Laboratories, Inc.

## **1.5 PERFORMANCE REQUIREMENTS**

- A. Clear and wireless glass ceramic and tempered float glass material; listed for use in fire-rated or fire/impact safety-rated insulated glass units in locations with fire rating requirements ranging from 20 to 3 hours with required hose stream test.
- B. Passes positive pressure test standards UL 10C.

## **1.6 QUALITY ASSURANCE**

- A. Glazing Standards: FGMA Glazing Manual and Sealant Manual.
- B. Fire Protective Rated Glass: Each lite shall bear permanent, nonremovable label of UL certifying it for use in tested and rated fire protective assemblies.

## **1.7 WARRANTY**

- A. Written warranty signed by manufacturer in which manufacturer agrees to replace insulating glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass:
  - 1. Warranty Period: Ten (10) years from date of Substantial Completion.

## **1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials to specified destination in manufacturer or distributor's packaging, undamaged, complete with installation instructions.
- B. Store off ground, under cover, protected from weather and construction activities.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturer:
  - 1. FireLite® IGU as manufactured by Technical Glass Products, 8107 Bracken Place SE, Snoqualmie, WA 98065 phone (800.426.0279) fax (425.396.8300) e-mail sales@fireglass.com, web site <http://www.fireglass.com>.
  - 2. Or Approved Equal.

### **2.2 MATERIALS**

- A. Primary Glass Products (AG - Annealed Glass) - ASTM C1036, Type I (transparent, flat), 1/4 inch (6 mm) thick float glass unless otherwise indicated:

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1. Clear Float: Class 1 (clear), Quality q<sup>3</sup> (glazing select).
  2. Tinted Float: Class 2 (tinted heat absorbing and light reducing), Quality q<sup>3</sup> (glazing select).
  3. [Green Nonreflective: LOF EverGreen Tint, uncoated tinted glass with shading coefficient 0.59 and average daylight transmittance 66 percent.]
  4. [Blue-Green: Uncoated blue-green tinted glass with shading coefficient 0.72 and average daylight transmittance 75 percent.]
  5. [Gray: Uncoated gray tinted glass with shading coefficient 0.65-0.67 and average daylight transmittance 44 percent.]
  6. [Dark Gray: Uncoated gray tinted glass with shading coefficient 0.64-0.66 and average daylight transmittance 13-15 percent.]
  7. [Bronze: Uncoated bronze tinted glass with shading coefficient 0.69-0.71 and average daylight transmittance 50-52 percent.]
  8. [Blue-Green Reflective: LOF Blue-Green Eclipse reflective glass, with coating on #2 surface, shading coefficient of 0.50 and average daylight transmittance 33 percent.]
  9. [Grey Reflective: LOF Grey Eclipse reflective glass, with coating on #2 surface, shading coefficient of 0.53 and average daylight transmittance 20 percent.]
- B. Heat-Treated Safety Glass - ASTM C1048:
1. TG - Tempered Glass, Clear: Kind FT, Condition A, Type I, Class and Quality as specified for primary clear float glass.
  2. TG - Tempered Glass, Tinted: Kind FT, Condition A, Type I, Class and Quality and Color as specified for primary tinted float glass.
- C. Sealed Insulating Glass Units - Class A:
1. Nominal Thickness: 1 inch (25.4 mm).
  2. Glass - Vision Units:
    - a. Two lites, one fire-rated and one tempered safety glass, as scheduled:
      - 1) Exterior Lite: Tinted float.
      - 2) Interior Lite:
        - a) Clear Fire Rated Wireless Glass-Ceramic with Premium surface finish.
        - b) Performance: **64** percent visible light transmittance and **12** percent visible light reflectance; winter nighttime U-value of **0.28**; summer daytime U-value of [Insert #]; and solar heat gain coefficient of **0.27**.
  3. Air Space Width: Nominal 1/2 inch measured perpendicularly from surfaces of glass lites at unit's edge.
  4. Sealing System: Dual seal, 10 year limited warranty.
  5. Spacer Specifications:
    - a. Manufacturer's standard stainless steel:
      - 1) Desiccant: Manufacturer's standard desiccant.
      - 2) Corner Construction: Manufacturer's standard corner construction.

## 2.3 MATERIALS-GLASS

- A. Properties – [FireLite®]:
1. Thickness: 3/16 inch [5 mm].
  2. Weight: 2.56 lbs/ft<sup>2</sup> or 12.5 kg/m<sup>2</sup>.
  3. Approximate Visible Transmission: 88 percent.
  4. Approximate Visible Reflection: 9 percent.
  5. Hardness (Vicker's Scale): 700.
  6. Fire-rating: 20 minutes to 90 minutes.
  7. Impact Safety Resistance: [None].
  8. Positive Pressure Test: UL 10C; passes.
  9. Surface Finish:

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- a. Standard Grade is polished for a surface quality that is comparable to alternative fire-rated ceramics marketed as having a premium finish.
  - b. Premium Grade is finish ground and polished on both surfaces to provide superior surface quality, improving overall clarity and providing a surface that is unmatched by alternative products.
  - c. Obscure-Patterned surface for privacy.
- B. Maximum sheet sizes based on surface finish:
- 1. Premium: 48 inches by 96 inches.
- C. Labeling: Permanently label each piece of Fire Rated Glazing with the UL logo and fire rating in sizes up to 3,325 sq. in.
- D. Fire Rating: Fire rating classified and labeled by UL for fire rating scheduled at opening locations on drawings, when tested in accordance with [ULC Standards CAN4 S-104 and CAN4 S-106] [NPFA 252 and NFPA 257] [UL 9 and UL 10B]. GLAZING COMPOUND FOR FIRE-RATED GLAZING MATERIALS.

## 2.4 MATERIALS-GLAZING COMPOUND FOR FIRE-RATED INSULATION GLASS UNITS

- A. Glazing Tape: Closed cell polyvinyl chloride (PVC) foam, coiled on release paper over adhesive on two sides, maximum water absorption by volume of 2 percent.
- B. Glazing Compound: DAP 33 putty.
- C. Silicone Sealant (Not to be used with FireLite NT unless used as a cap bead/seal):
- 1. One-part neutral curing silicone, medium modulus sealant, Type S; Grade NS; Class 25 with additional movement capability of 50 percent in both extension and compression (total 100 percent); Uses (Exposure) NT\*; Uses (Substrates) G, A, and O as applicable:
    - a. Available Products:
      - 1) Dow Corning 795 - Dow Corning Corp.
      - 2) Silglaze-II 2800 - General Electric Co.
      - 3) Spectrem 2 - Tremco Inc.]
- D. Setting Blocks: Neoprene, EPDM, or silicone; tested for compatibility with glazing compound; of 70 to 90 Shore A hardness.
- E. Cleaners, Primers, and Sealers: Type recommended by manufacturer of glass and gaskets.

## 2.5 FABRICATION

- A. Fabricate glass and other glazing products in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with recommendations of product manufacturer and referenced glazing standard as required to comply with system performance requirements.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Comply with referenced FGMA standards and instructions of manufacturers of glass, glazing sealants, and glazing compounds.
- B. Protect glass from edge damage during handling and installation. Inspect glass during

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installation and discard pieces with edge damage that could affect glass performance.

- C. Set units of glass in each series with uniformity of pattern, draw, bow, and similar characteristics.
- D. Cut glazing tape to length and set against permanent stops, flush with sight lines to fit openings exactly, with stretch allowance during installation.
- E. Place setting blocks located at quarter points of glass with edge block no more than 6 inches from corners.
- F. Glaze vertically into labeled fire-rated metal frames with same fire rating as glass and push against tape for full contact at perimeter of pane or unit.
- G. Place glazing tape on free perimeter of glazing in same manner described above.
- H. Install removable stop and secure without displacement of tape.
- I. Install so that appropriate UL markings remain permanently visible.

### **3.2 PROTECTION AND CLEANING**

- A. Protect glass from contact with contaminating substances resulting from construction operations. Remove any such substances by method approved by glass manufacturer.
- B. Wash glass on both faces not more than four days prior to date scheduled for inspections intended to establish date of substantial completion. Wash glass by method recommended by glass manufacturer.

**END OF SECTION 08 81 17**

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## **SECTION 08 83 00 MIRRORS**

### **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 requirements including but not limited to:
  - 1. Tempered glass mirrors qualifying as safety glazing.
  - 2. Accessories necessary for a complete installation.
- B. Related Sections:
  - 1. Section 06 10 00: Rough Carpentry

#### **1.3 DEFINITIONS**

- A. Deterioration of Mirrors: Defects developed from normal use attributable to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning mirrors contrary to mirror manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. Provide mirrors that will not fail under normal usage. Failure includes glass breakage and deterioration attributable to defective manufacture, fabrication, and installation.

#### **1.5 SUBMITTALS**

- A. Product Data: Technical data for mirror units including description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality control provisions.
- B. Shop Drawings: Submit mirror elevations, edge details, mirror hardware, and attachments to other work.

#### **1.6 QUALITY ASSURANCE**

- A. Regulatory Requirements:
  - 1. Accessibility Requirements - Comply with applicable requirements:
    - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG) 2010.
    - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
    - c. CBC 11B.
  - 2. Glazing Publications - Comply with published recommendations:
    - a. GANA *Glazing Manual* unless more stringent requirements are indicated.
    - b. GANA Mirror Division Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors.
  - 3. Safety Glazing Products: For tempered mirrors, provide products complying with testing requirements in 16 CFR 1201 for Category II materials.

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- B. Installer Qualifications: Experienced installer having minimum 5 years documented experience and has completed mirror glazing similar in material, design, and extent to that indicated.
- C. Source Limitations for Mirrors: Obtain mirrors from one source for each type of mirror indicated.
- D. Source Limitations for Mirror Glazing Accessories: Obtain mirror glazing accessories from one source for each type of accessory indicated.
- E. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing and substrates on which mirrors are installed.
- F. 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 material, whichever is less

## 1.7 WARRANTY

- A. Warranty: Warranty made out to Owner and signed by mirror manufacturer agreeing to replace mirrors that deteriorate, f.o.b. the nearest shipping point to site, within specified warranty period:
  - 1. Warranty Period: Five years from date of Substantial Completion.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect mirrors according to mirror manufacturer's written instructions and necessary to prevent damage to mirrors from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors, protected from moisture including condensation.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Manufacturers: Subject to compliance with requirements, provide mirrors by one of the following:
  - 1. Guardian Industries Corp.
  - 2. Arch Aluminum & Glass Co., Inc.
  - 3. Virginia Mirror Company, Inc.
  - 4. VVP America, Inc.; Binswanger Mirror Products.
  - 5. Walker Glass Co., Ltd.
- B. Tempered Glass Mirrors: Comply with ASTM C 1503, Mirror Glazing Quality, for blemish requirements in annealed float glass before silver coating is applied, for coating requirements, and with other requirements not affected by tempering process; and comply with ASTM C 1048 for Kind FT, Condition A, tempered float glass before silver coating is applied.
  - 1. Nominal Thickness: 6.0 mm.
  - 2. Safety Glazing Products: For tempered mirrors, provide products that comply with



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#### 16 CFR 1201, Category II.

- C. Setting Blocks: Elastomeric material with Type A Shore durometer hardness of 85, plus or minus 5.
- D. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.
- E. Mirror Mastic: Adhesive setting compound, produced specifically for setting mirrors and certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed. Provide product recommended by mirror manufacturer.
- F. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.
- G. Top and Bottom Aluminum J-Channels:
  - 1. Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece:
    - a. Bottom Trim - J-channels formed with front leg and back leg not less than 3/8 inch and 7/8 inch (9.5 mm and 22 mm) in height, respectively, and a thickness of not less than 0.04 inch (1.0 mm):
      - 1) Products are subject to compliance with requirements; provide one of the following:
        - a) Laurence, C. R. Co., Inc.; CRL Standard "J" Channel.
        - b) Sommer & Maca Industries, Inc.; Aluminum Shallow Nose "J" Moulding Lower Bar.
  - 2. Top Trim:
    - a. J-channels formed with front leg and back leg not less than 5/8 and 1 inch (16 and 25 mm) in height, respectively, and a thickness of not less than 0.04 inch (1.0 mm):
      - 1) Products are subject to compliance with requirements; provide one of the following:
        - a) Laurence, C. R. Co., Inc.; CRL Deep "J" Channel.
        - b) Sommer & Maca Industries, Inc.; Aluminum Deep Nose "J" Moulding Upper Bar.
  - 3. Finish: Clear.
- H. Top and Bottom Clips: As indicated.
- I. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.
- J. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead shield expansion bolt devices for drilled in place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

## 2.2 FABRICATION

- A. Mirror Sizes: To suit conditions, and before tempering, cut mirrors to final sizes and shapes.
- B. Cutouts: Fabricate cutouts for notches and holes in mirrored glass without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrored glass.

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- C. Mirror Edge Treatment:
  - 1. Cutting and Polishing: Flat edges where the clean cut square edge of the glass is flat and surface edges are slightly arressed. After grinding the arisses, polish edges to a high gloss surface where the surface reflectivity is similar in appearance to the major surface of the glass.
  - 2. Edge Sealing: Immediately after cutting to final sizes, and applying edge treatment, factory seal edges of mirrors with edge sealer to prevent chemical or atmospheric penetration of glass coating.
- D. Film Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint as recommended in writing by film backing manufacturer to produce a surface free of bubbles, blisters, and other imperfections.

## **PART 3 EXECUTION**

### **3.1 FIELD CONDITIONS**

- A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

### **3.2 EXAMINATION**

- A. Examine substrates, over which mirrors are to be mounted for compliance with installation tolerances, substrate preparation, and conditions affecting performance. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers. Proceed with mirror installation after unsatisfactory conditions have been corrected and surfaces are dry.

### **3.3 PREPARATION**

- A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating surfaces with mastic manufacturer's special bond coating where applicable.

### **3.4 INSTALLATION**

- A. Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images. Provide minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
- B. Wall Mounted Mirrors: Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors:
  - 1. For metal or plastic clips, place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges.
  - 2. Top and Bottom Aluminum J-Channels: Provide setting blocks 1/8 inch (3 mm) thick by 4 inches (100 mm) long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch (6.4 mm) wide by 3/8 inch (9.5 mm) long at bottom channel.
  - 3. Mirror Clips - Place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges. Locate clips to be symmetrically placed and evenly spaced:
    - a. Fabricate bottom trim in single lengths to fit and cover bottom edges of mirrors.

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- Locate top clips so they are symmetrically placed and evenly spaced.
4. Mastic - Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface:
    - a. Apply mastic in vertical beads or mounds to the wall, not to the mirror back to avoid potential damage caused by mastic applicator tools, in compliance with mastic manufacturer's written instructions to allow air circulation between back of mirrors and face of mounting surface.
    - b. Make each vertical bead approximately 1/2 inch in width with minimum of one bead for every square foot of mirror.
    - c. Make each mound approximately 1-1/2 inch in diameter with a minimum of one mound for every square foot of mirror.
    - d. Do not apply mastic within 6 inches of the mirror edges to prevent squeeze out. Place beads or mounds leaving a space between mirror and wall. After mastic is applied, align mirrors and press into place. Spread each vertical bead to approximately 2 inches in width and spread each mound to a pat approximately 3-1/2 inch in diameter after pressing mirror into place.
    - e. After mastic is applied, align mirrors and press into place while maintaining a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface.

### **3.5 CLEANING AND PROTECTION**

- A. Protect mirrors from breakage and contaminating substances resulting from construction operations. Do not permit edges of mirrors to be exposed to standing water. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.
- B. Wash exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash mirrors as recommended in writing by mirror manufacturer.

**END OF SECTION 08 83 00**

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## **SECTION 09 21 16 GYPSUM BOARD ASSEMBLIES**

### **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 requirements including but not limited to:
  - 1. Gypsum Board.
  - 2. Reinforced Gypsum Board Sheathing (Tile Backer Board).
  - 3. Cementitious Backer Units.
  - 4. Accessories necessary for a complete installation.
- B. Related Sections:
  - 1. Section 05 50 00: Metal Fabrications.
  - 2. Section 06 10 00: Rough Carpentry.
  - 3. Section 08 11 13: Hollow Metal Doors and Frames.
  - 4. Section 08 31 13: Access Door and Frames.
  - 5. Section 08 51 00: Aluminum Windows.
  - 6. Section 09 30 00: Tiling.
  - 7. Section 09 90 00: Painting and Coating.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Comply with manufacturer's load tables and the following design pressures and deflections:
  - 1. Stairs, Elevator Hoistways, and Vertical Shafts: 1/120 at 10 psf.
  - 2. Ground Floor Lobbies: 1/120 at 15 psf.
  - 3. Partitions Receiving Lath and Plaster, or Plaster Veneer: 1/360 at 15 psf.
  - 4. Partitions Receiving Monitors, Televisions, Heavy Audio/Visual Equipment: 1/360 at 15 psf.
  - 5. Typical Partitions: 1/240 at 5 psf.
  - 6. Other Partitions: 1/240 at 5 psf.
  - 7. Maximum Deflection:
    - a. L/240 at 5 lbf per sq. ft.
    - b. L/120 at 5 lbf per sq. ft.
    - c. L/120 at 7.5 lbf per sq. ft.
    - d. L/120 at 10 lbf per sq. ft.
- B. Fire Resistance Rated Assemblies: For fire resistance rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- C. STC Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

#### **1.4 SUBMITTALS**

- A. Product Data: Submit For each type of drywall including calculations for loadings and stresses of exterior walls and specially fabricated framing based on manufacturer's load

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tables.

- B. Shop Drawings: Indicate locations, fabrication, and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other units of Work.
- C. Samples:
  - 1. Trim Accessories: Full size Sample in 12 inch (300 mm) long length for each trim accessory indicated.
  - 2. Textured Finishes: 12 inch by 12 inch (300 mm by 300 mm) for each textured finish indicated and on same backing indicated for Work.
- D. Calculations: Submit calculations verifying steel partition stud minimum base metal thickness and depth compliance with Code and ASTM C645 for height, load, and deflection.
- E. Evaluation Reports: ICC-ES reports for dimpled steel studs and runners and firestop tracks.

## 1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. CBC 2016 California Building Code (CCR Title 24, Part 2, as adopted and amended by DSA):
    - a. CBC– Chapter 7, Fire Resistant Materials and Construction
    - b. CBC – Chapter 19A, Concrete
    - c. CBC – Chapter 25, Gypsum Board and Plaster.
  - 2. Division of the State Architect, Interpretation of Regulations (DSA-IR):
    - a. DSA-IR 25-3, Drywall Ceiling Suspension Conventional Construction-One Layer.
    - b. DSA-IR 25-2.13, Metal Suspension Systems for Lay in Panel Ceilings.
  - 3. Fire Resistance Rated Assemblies: For fire resistance rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
  - 4. Fire Resistance Rated Assemblies: For fire resistance rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. Single Source Responsibility:
  - 1. Wood Framing Members: Refer to drawing S0.03 Standard General Notes.
  - 2. Steel Framing Members: Obtain steel framing members from single manufacturer.
  - 3. Panel Products: Obtain each type of gypsum board and other panel products from single manufacturer.
  - 4. Finishing Materials: To the extent possible, obtain finishing materials from same manufacturer supplying gypsum board products. When not possible, obtain materials from manufacturer acceptable to gypsum board manufacturer.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

## PART 2 PRODUCTS

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## 2.1 MATERIALS

- A. Manufacturers are subject to compliance with requirements; provide products by one of the following:
  1. Gypsum Board.
  2. Cementitious Board:
    - a. USG Corporation; Durock Brand Cement Board.
- B. Gypsum Board - ASTM C 1396/C 1396M, applicable to type of gypsum board indicated and whichever is more stringent:
  1. Core - Use Type X throughout:
    - a. Thickness: 5/8 inch (15.9 mm).
    - b. Long Edges: Tapered and featured (rounded or beveled) for prefilling.
  2. Ceiling Type - Manufactured for sag resistance:
    - a. Thickness: 1/2 inch (13mm).
    - b. Long Edges: Tapered.
  3. Moisture and Mold Resistant Type - Type X with moisture and mold resistant core and surfaces. Core:
    - a. Thickness: 5/8 inch (15.9 mm).
    - b. Long Edges: Tapered.
- C. Acoustically Enhanced Gypsum Board - ASTM C 1396/C 1396M. Multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core:
  1. Manufacturers are subject to compliance with requirements; provide products by one of the following:
    - a. National Gypsum Company, Sound Break XP
    - b. Quiet Solution.
  2. Core:
    - a. Inner layer: Viscoelastic damping polymer
    - b. Outer layers: Enhanced, high density mold-resistant gypsum core
  3. Overall Thickness: 5/8 inch
  4. Type: Type "x".
  5. Long Edges: Tapered.
- D. Reinforced Gypsum Sheathing (Tile Backer Board) - ASTM C 1278/C 1278M, standard edges. Cellulose fiber reinforced panels may be used in lieu of cementitious board:
  1. Core and Thickness: 1/2 inch (12.7 mm) or 5/8 inch (15.9 mm) to match conditions, Type X.
  2. Long Edge: Tapered.
  3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- E. Cementitious Backer Units - ANSI A118.9 and ASTM C 1288 or ASTM C 1325:
  1. Thickness: 1/2 inch (12.7 mm) and 5/8 inch (15.9 mm) to match conditions, Type X
  2. Long Edges: Standard.
  3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- F. Interior Trim - ASTM C 1047, galvanized or aluminum coated steel sheet, rolled zinc, plastic, or paper faced galvanized steel sheet:
  1. Shapes:
    - a. Cornerbead.
    - b. Bullnose bead.
    - c. LC Bead: J shaped; exposed long flange receives joint compound.
    - d. L Bead: L shaped; exposed long flange receives joint compound.
    - e. U Bead: J shaped; exposed short flange does not receive joint compound.
    - f. Expansion (control) joint.

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2. Manufacturers are subject to compliance with requirements; provide products by one of the following:
  - a. Pittcon Industries.
  - b. Fry Reglet Corp.
  - c. Gordon, Inc.
  
- G. Continuous Corner - Extruded Aluminum, continuous integral fin for surface contact with gypsum board; 7/8 inch (22 mm) wide, tapered to edge; punched with holes staggered to accept screw fastening. Prime with corrosion resistant primer. Provide Pittcon Softforms (Basis of Design) or Schluter:
  1. Subject to compliance with requirements, provide basis of design or comparable by one of the following:
    - a. Pittcon Industries.
    - b. Fry Reglet Corporation.
    - c. Schluter.
  
- H. Joint Treatment - ASTM C 475/C 475M:
  1. Joint Tape:
    - d. Interior Gypsum Board: USG Sheetrock Brand Paper Tape.
    - d. Cementitious Board: USG Durock Tape.
  2. Joint Compound:
    - a. Gypsum Board – Prefilling - At open joints, rounded or beveled panel edges, and damaged surface areas, use setting type taping compound: USG Sheetrock Brand Easy Sand Setting-Type Joint Compound:
      - 1) Embedding and First Coat - For embedding tape and first coat on joints, fasteners, and trim flanges, use setting type taping compound. USG Sheetrock Brand All Purpose Joint Compound:
        - a) Use setting type compound for installing paper faced metal trim accessories: USG Sheetrock Brand All Purpose Joint Compound.
      - 2) Fill Coat: For second coat, use setting type, sandable topping compound: USG Sheetrock Brand Topping Joint Compound.
      - 3) Finish Coat: For third coat, use setting type, sandable topping compound: USG Sheetrock Brand Topping Joint Compound.
      - 4) Skim Coat: For final coat of Level 4 finish, use setting type, sandable topping compound: USG Sheetrock Brand Topping Joint Compound.
    - b. Cementitious Units: USG Sheetrock Brand Easy Sand Setting-Type Joint Compound.
    - c. Tile Backing Panels: USG Sheetrock Brand Easy Sand Setting-Type Joint Compound.
    - d. Water Resistant Gypsum Backing Board: Use setting type taping compound and setting-type, sandable topping compound: USG Sheetrock Brand Easy Sand Setting-Type Joint Compound.
  
- I. Auxiliary Gypsum Materials - Comply with referenced installation standards and manufacturer's written recommendations:
  1. Steel Drill Screws: ASTM C 1002, use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
  2. Sound Attenuation Blankets:
    - a. ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool:
      - 1) Fire Resistance Rated Assemblies: Comply with mineral-fiber requirements of assembly.
  3. Acoustical Sealant:
    - a. Nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product



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effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90:

- 1) USG Corporation; Sheetrock Brand Acoustical Sealant

## **PART 3 EXECUTION**

### **3.1 PROJECT CONDITIONS**

- A. Environmental Limitations:
  1. Comply with ASTM C840 for gypsum board manufacturer's written instructions, whichever are more stringent:
    - a. Do not install paper faced gypsum panels until installation areas are enclosed and conditioned.
- B. Room Temperatures: Maintain minimum 40 degrees F (4 degrees C). For adhesive attachment and finishing of gypsum board, maintain minimum 50 degrees F (10 degrees C) for 48 hours before application and continuously after until dry. Do not exceed 95 degrees F (35 degrees C) when using temporary heat sources.
- C. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.
- D. Do not install panels that are wet, moisture damaged, and mold damaged:
  1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

### **3.2 EXAMINATION**

- A. Examine areas and substrates including welded hollow metal frames, cast in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation after unsatisfactory conditions have been corrected.

### **3.3 PREPARATION**

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

### **3.4 INSTALLATION**

- A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.
- B. Gypsum Board Assemblies: Comply with requirements in ASTM C 840 applicable to framing installation.
- C. Sound Insulation: Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.



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D. Gypsum Panels:

1. Comply with ASTM C 840. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged:
  - a. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
  - b. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
  - c. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
  - d. Form control and expansion joints with space between edges of adjoining gypsum panels.
  - e. Cover both faces of support framing with gypsum panels in concealed spaces, except in chases braced internally:
    - 1) Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
    - 2) Fit gypsum panels around ducts, pipes, and conduits.
    - 3) Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4 inch to 3/8 inch (6.4 mm to 9.5 mm) wide joints to install sealant.
  - f. Isolate perimeter of gypsum board applied to nonload bearing partitions at structural abutments, except floors. Provide 1/4 inch to 1/2 inch (6.4mm to 12.7mm) wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
  - g. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

E. Gypsum Board:

1. Install interior gypsum board where indicated on drawings:
  - a. Single Layer Application:
    - 1) On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
    - 2) On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire resistance rated assembly, and minimize end joints. Stagger abutting end joints not less than one framing member in alternate courses of panels.
    - 3) Fastening Methods: Apply gypsum panels to supports with steel drill screws.
2. Multilayer Application:
  - a. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
  - b. On Z shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
  - c. Fastening Methods: Fasten base layers and face layers separately to supports with

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screws.

- F. Backing Panels:
  - 1. Cementitious Backer Units: ANSI A108.11; install where indicated with 1/4 inch (6.4 mm) gap where panels abut other construction or penetrations. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.
- G. Trim Accessories:
  - 1. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Attach trim according to manufacturer's written instructions:
    - a. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
    - b. Exterior Trim: Install in the following locations:
      - 1) Cornerbead: Use at outside corners.
      - 2) LC Bead: Use at exposed panel edges.
    - c. Interior Trim - Install in the following locations:
      - 1) Cornerbead: Use at outside corners, unless otherwise indicated.
      - 2) Bullnose Bead: Use at outside corners.
      - 3) LC Bead: Use at exposed panel edges.
      - 4) L Bead: Use where indicated or necessary.
      - 5) U Bead: Use at exposed panel edges.
- H. Gypsum Board Finishing:
  - 1. Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces:
    - a. Prefill open joints, rounded or beveled edges, and damaged surface areas.
    - b. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
    - c. Gypsum Board Finish Levels - Finish panels to levels indicated below and according to ASTM C 840:
      - 1) Level 1: Ceiling plenum areas, concealed areas, and where indicated.
      - 2) Level 2: Panels that are substrate for tile.
      - 3) Level 3: Surfaces be coated with drywall primer prior to final finishes. Heavy or medium texture finishes before final painting, or where heavy-grade wall coverings are to be applied as the final decoration. This level of finish is not recommended where smooth painted surfaces, or light to medium weight wall coverings as specified.
      - 4) Level 4: For surfaces receiving wall covering and flat paints.
      - 5) Level 5: For surfaces receiving gloss or semigloss paint and surfaces subjected to severe lighting. To be used in Kitchen areas and food service areas only.
- I. Installation Tolerances:
  - 1. Suspension System: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.
  - 2. Installation Tolerances, Suspension System: Install suspension systems level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

### 3.5 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight,

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construction, and other causes during remainder of the construction period.

- B. Remove and replace panels that are wet, moisture damaged, and mold damaged:
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

**END OF SECTION 09 21 16**

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## **SECTION 09 24 00 CEMENT PLASTERING**

### **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 requirements including but not limited to:
  - 1. Exterior plasterwork (stucco).
  - 2. Metal framing and accessories.
  - 3. Metal lath and furring.
  - 4. Accessories necessary for a complete installation.
- B. Related Sections:
  - 1. Section 05 50 00: Metal Fabrications.
  - 2. Section 06 10 00: Rough Carpentry.
  - 3. Section 07 25 00: Weather Barriers
  - 4. Section 07 92 00: Joint Sealants.
  - 5. Section 09 21 16: Gypsum Board Assemblies.
  - 6. Section 09 90 00: Painting and Coating.

#### **1.3 SUBMITTALS**

- A. Product Data: Submit technical data for product and accessory, including construction details and material descriptions.
- B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.

#### **1.4 QUALITY ASSURANCE**

- A. Regulatory Requirements:
  - 1. Building Code:
    - a. Comply with applicable provisions of the CBC 2019 California Building Code (CCR Title 24, Part 2, as adopted and amended by DSA):
      - 1) CBC 2019, 2507.3 Attachment requirements.
  - 2. Fire Resistance Ratings: Where indicated, provide cement plaster assemblies identical to those of assemblies tested for fire resistance according to ASTM E 119 by a qualified testing agency.
- B. Pre-installation Conference: Conduct conference at site.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver cementitious materials in original packages, containers, or bundles, labeled with manufacturer's name, product brand name, and lot number.
- B. Store materials inside under cover, and keep them dry and protected against damage from weather, moisture, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

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## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Manufacturers are subject to compliance with requirements; provide products of one of the following:
  - 1. Metal Lath and Accessories:
    - a. Alabama Metal Industries.
    - b. CEMCO.
    - c. ClarkDietrich Building Systems.
    - d. Marino/WARE.
    - e. Phillips Manufacturing.
  - 2. Wire Fabric Lath:
    - a. Davis Wire.
    - b. Jaenson Wire Company.
    - c. Keystone Steel and Wire Co.
    - d. K-Lath.
  - 3. Plastic Accessories:
    - a. Alabama Metal Industries.
    - b. Phillips manufacturing.
    - c. Plastic Components.
    - d. Vinyl Corp.
  - 4. Ready Mixed Finish Coat Plaster:
    - a. Omega Products International.
    - b. California Stucco Product.
    - c. El Rey Solutions.
    - d. Florida Stucco.
    - e. Quikrete.
    - f. Shamrock Stucco.
- B. Metal Lath:
  - 1. Expanded Metal Lath:
    - a. ASTM C 847, cold rolled carbon steel sheet with ASTM A 653/A 653M, G60 (Z180), hot dip galvanized zinc coating:
      - 1) Diamond Mesh Lath: Self furring, 3.4 lb/sq. yd. (1.8 kg/sq. m).
      - 2) Comply with DSA IR 25-4 for the installation of Self-Furring Metal Lath.
  - 2. Building Wrap:
    - a. Spun-bounded high density polyethylene fibers. No binders or fillers. As manufactured by: Dupont Tyvek Commercial Wrap or approved equal.
- C. Accessories:
  - 1. Comply with ASTM C 1063, and coordinate depth of trim and accessories with thicknesses and number of plaster coats required:
    - a. Metal Accessories:
      - 1) Foundation Weep Screed: Fabricated from hot dip galvanized steel sheet, ASTM A 653/A 653M, G60 (Z180) zinc coating.
      - 2) Cornerite: Fabricated from metal lath with ASTM A 653/A 653M, G60 (Z180), hot dip galvanized-zinc coating.
      - 3) Outside Corner Reinforcement: Fabricated from metal lath with ASTM A 653/A 653M, G60 (Z180), hot dip galvanized zinc coating.
      - 4) Cornerbeads - Fabricated from zinc or zinc coated (galvanized) steel:
        - a) Smallnose cornerbead with expanded flanges; use unless otherwise indicated.
      - 5) Casing Beads: Fabricated from zinc or zinc coated (galvanized) steel; square edged style; with expanded flanges.

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- D. Miscellaneous Materials:
  - 1. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
  - 2. Fiber for Base Coat: Alkaline resistant glass or polypropylene fibers, 1/2 inch (13 mm) long, free of contaminants, manufactured for use in cement plaster.
  - 3. Bonding Compound: ASTM C 932.
  - 4. Fasteners for Attaching Metal Lath to Substrates: ASTM C 1063.
  - 5. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475 inch (1.21 mm) diameter unless otherwise indicated.
- E. Plaster Materials:
  - 1. Portland Cement - ASTM C 150/C 150M, Type I or II:
    - a. Color for Finish Coats: Match existing.
  - 2. Colorants for Job Mixed Finish Coats: Colorfast mineral pigments that produce finish plaster color selected by Architect.
  - 3. Lime: ASTM C 206, Type S; or ASTM C 207, Type S.
  - 4. Sand Aggregate - ASTM C 897:
    - a. Color for Job Mixed Finish Coats: White.
  - 5. Exposed Aggregates for Finish Coats: Match existing.
  - 6. Ready Mixed Finish Coat Plaster:
    - a. Mill mixed portland cement, aggregates, coloring agents, and proprietary ingredients.
      - 1) Color: Selected by Architect.

## 2.2 PLASTER MIXES

- A. Comply with ASTM C 926 for applications indicated:
  - 1. Fiber Content: Add fiber to base coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed 1 lb of fiber/cu. yd. (0.6 kg of fiber/cu. m) of cementitious materials.
- B. Base Coat Mixes for Use over Metal Lath:
  - 1. Scratch and brown coats for three coat plasterwork:
    - a. Portland Cement Mix:
      - 1) Scratch Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
      - 2) Brown Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
- C. Job Mixed Finish Coat Mixes:
  - 1. Portland Cement Mix: For cementitious materials, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
- D. Factory Prepared Finish Coat Mixes: For ready mixed finish coat plasters or acrylic based finish coatings, comply with manufacturer's written instructions.

## PART 3 EXECUTION

### 3.1 PROJECT CONDITIONS

- A. Comply with applicable requirements of ASTM C 926.

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- B. Environmental Requirements: Comply with requirements of referenced plaster application standards and recommendations of plaster manufacturer for environmental conditions before, during, and after plaster application.
- C. Cold Weather Requirements: Provide heat and protection, temporary or permanent, as required to protect each coat of plaster from freezing for at least 24 hours after application. Distribute heat uniformly to prevent concentration of heat on plaster near heat sources; provide deflection or protective screens.
- D. Warm Weather Requirements: Protect plaster against uneven and excessive evaporation and from strong flows of dry air, both natural and artificial. Apply and cure plaster as required by climatic and job conditions to prevent dry out during cure period. Provide suitable coverings, moist curing, barriers to deflect sunlight and wind, or combinations of these, as required.
- E. Ventilation: Provide natural or mechanical means of ventilation to properly dry interior spaces after portland cement plaster has cured.
- F. Exterior Plasterwork:
  - 1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
  - 2. Apply plaster when ambient temperature is greater than 40 degrees F (4.4 degrees C).
  - 3. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.
- G. Protect contiguous Work from soiling and moisture deterioration caused by plastering. Provide temporary covering and take precautions necessary to minimize spattering of plaster on adjacent Work.
- H. Factory Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

### **3.2 EXAMINATION**

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Proceed with installation after correcting unsatisfactory conditions.

### **3.3 PREPARATION**

- A. Protect adjacent Work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.
- B. Prepare smooth, solid substrates for plaster according to ASTM C 926.

### **3.4 INSTALLATION**

- A. Metal Lath:
  - 1. Install according to ASTM C 1063:
    - a. Partition Framing and Vertical Furring: Flat diamond mesh lath.
    - b. Horizontal Framing: Flat diamond mesh lath.
- B. Accessories:
  - 1. Install according to ASTM C 1063 and at locations indicated on Drawings:

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- a. Reinforcement for External (Outside) Corners:
  - 1) Install cornerbead at exterior locations.

### 3.5 PLASTER APPLICATION

- A. Comply with ASTM C 926:
  - 1. Do not deviate more than plus or minus 1/4 inch in 10 feet (6 mm in 3 m) from a true plane in finished plaster surfaces when measured by a 10-foot (3-m) straightedge placed on surface.
  - 2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
  - 3. Provide plaster surfaces ready to receive field applied finishes indicated.
- B. Flat Surface Tolerances: Do not deviate more than plus or minus 1/8 inch in 10 feet (3 mm in 3 m) from a true plane in finished plaster surfaces, measured by a 10 foot (3m) straightedge placed at any location on surface.
- C. Walls; Base Coat Mixes for Use over Metal Lath:
  - 1. For scratch and brown coats, for three coat plasterwork with 3/4 inch (19 mm) total thickness:
    - a. Portland cement mixes.
- D. Plaster Finish Coats: Apply to provide dash finish.
- E. Concealed Exterior Plasterwork: Where plaster application is used as a base for adhered finishes, omit finish coat.

### 3.6 PLASTER REPAIRS

- A. Repair or replace Work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.
- B. Cut, patch, replace, repair, and point up plaster as necessary to accommodate other Work. Repair cracks and indented surfaces. Point up finish plaster surfaces around items that are built into or penetrate plaster surfaces. Repair or replace Work to eliminate blisters, buckles, check cracking, dry outs, efflorescence, excessive pinholes, and similar defects. Repair or replace work as necessary to comply with required visual effects.

### 3.7 TOLERANCES

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

### 3.8 CLEANING AND PROTECTION

- A. Remove temporary protection and enclosure of Work after plastering is complete. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.
- B. Remove unused materials, containers, equipment, and plaster debris.



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- C. Protect plaster and maintain conditions ensuring finished plaster is without damage or deterioration at time of Substantial Completion.

**END OF SECTION 09 24 00**

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## **SECTION 09 30 19 TILING**

### **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. Thin set porcelain tile, mortar and grout, sealants, and accessories shown or required to complete work.
- B. Related Sections:
  - 1. Section 03 30 00: Cast-In-Place Concrete.
  - 2. Section 09 21 16: Gypsum Board Assemblies.

#### **1.3 SUBMITTALS**

- A. Product Data: Technical data including data sheets, installation recommendation, and recommended joint widths.
- B. Shop Drawings - Show locations of each type of tile and tile pattern:
  - 1. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples - Submit samples showing full range of color and texture variations expected:
  - 1. Full size units of each type and composition of tile and for each color and finish required.
  - 2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required; minimum 12 inches (300 mm) square, but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.
  - 3. Waterproof membrane in 6 x 6-inch sample.
  - 4. Thresholds in 6 inch (150 mm) lengths.
- D. Test Reports: Submit test reports from qualified independent testing laboratory indicating and interpreting test results relative to compliance of tile products with requirements for slip resistance.
- E. Maintenance Instructions: Submit maintenance instructions for each type of product specified.
- F. Certifications:
  - 1. Provide Master Grade Certificate as specified in ANSI A137.1.
  - 2. Manufacturer's affidavits that materials used contain no asbestos.

#### **1.4 QUALITY ASSURANCE**

- A. Regulatory Requirements:
  - 1. Building Code: Comply with applicable requirements for the CBC for interior finishes.
  - 2. Surface Burning Characteristics - ASTM E 84; identify products with appropriate



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- H. Pre-Installation Conference:  
1. Refer to Section 01 31 00: Project Meetings

## 1.5 WARRANTY

- A. Warrant the Work specified herein for one (1) year against becoming unserviceable or causing an objectionable appearance resulting from either defective, or nonconforming materials and workmanship.
- B. Defects shall include, but not be limited to, the following:
1. Damaged tile, including broken or chipped edges.
  2. Loose or missing tile.
  3. Noticeable deterioration or discoloring of tile or grout.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided. Store liquid materials in unopened containers and protected from freezing.
- C. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Specifications are based on products of manufacturers specified. Manufacturers listed below who produce equivalent products to those specified are approved for use on the Project. Other manufacturers must have a minimum of five (5) years' experience manufacturing equivalent products to those specified and comply with Division 1 requirements regarding substitutions in order to be considered:
1. Porcelain Tile:
    - a. Redfin Ceramiche
    - b. No substitutions
  2. Tile Setting and Grout Materials - Those manufactured by any one (1) of the following:
    - a. Custom Building Products; (562) 598-8808.
    - b. Dal-Tile Corp.; (713) 481-5893.
    - c. Laticrete International, Inc., Bethany, CT; (800) 243-4788.
    - d. Mapei Americas; (800) 426-2734.
    - e. No substitutions.
- B. Specifications are based on porcelain tile as manufactured by Redfin Ceramiche. Other manufacturers listed shall provide colors and finish equivalent to those specified.

### 2.2 MATERIALS

- A. Type A - 12 inches by 24 inches by 5/16 inch thick (Mounted on ½ inch plywood sample) porcelain tile with cushioned edge and manufacturer's standard slip resistant finish:
1. Manufacturer: Redfin Ceramiche

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2. Product Line: Fusion
  3. Color: Ash and Grey
  4. Locations: Restroom
  5. Base: 6 inch high x 12 inch long porcelain tile base to match porcelain tile.
  6. Borders and Patterns: Stacked bond - landscape
- B. Mortar Adhesive: LATICRETE® 254 Platinum Thin-Set Mortar as manufactured by Laticrete International, Inc., Bethany, CT; (800) 243-4788, FlexBond Premium Flexible Bonding Mortar as manufactured by Custom Building Products, Seal Beach, CA; (562) 598-8808, or 1300 Universal Bonding Mortar as manufactured Dal-Tile Corp., Dallas, TX; (800)-933-8453, Ultraflex 3 as manufactured by Mapei Americas, Deerfield Beach, FL; (800)-426-2734. No substitutions.
- C. Epoxy Grout (At wet areas and restroom floors and walls) - Use one (1) of the following 100 percent solids epoxy grout in accordance with ANSI A118.3. No substitutions. Color shall be as selected by Architect from manufacturer's full line of available colors:
1. ARDEX L.P., WA Epoxy Grout; (724) 203-5000.
  2. Polyblend® Tile Grout with 100 percent Solids Epoxy manufactured by Custom Building Products; (562) 598-8808.
  3. LATICRETE® SpectraLOCK PRO Stainless Grout manufactured by Laticrete International, Inc.; (800) 243-4788.
  4. Kerapoxy IEG, 100% Solids, Industrial-Grade Epoxy Grout manufactured by Mapei Americas; (800)-426-2734.
- D. Crack Isolation Membrane:
1. Sheet membrane used to eliminate transmission of substrate cracks from one (1) of the following approved Products/Manufacturers:
    - a. Dalseal CIS manufactured by Dal-Tile.
    - b. Crackbuster manufactured by Custom Building Products.
    - c. Mapelastic SM manufactured by Mapei.
    - d. Nobleseal CIS manufactured by The Noble Company.
    - e. Tileguard manufactured by Polyguard Products, Inc.
  2. Liquid membrane with fiberglass mesh from one (1) of the following approved Products/Manufacturers in accordance with ANSI A118.12:
    - a. Blue 92 manufactured by Laticrete International, Inc.
    - b. Fracturefree manufactured by Custom Building Products.
  3. Alternate, in lieu of those specified above:
    - a. Type: Polyethylene membrane with a grid structure of square cavities, each cut back in a dovetail configuration, and an anchoring fleece laminated to its underside.
    - b. Approved Product/Manufacturer: Schluter DITRA 30, manufactured by Schluter Systems, (800) 472-4588.
- E. Expansion Joint:
1. Filler: Flexible and compressible, closed-cell type, rounded at surface to contact sealant as instructed by sealant manufacturer to suit intended use.
  2. Typical Conditions except as specified below: Silicone compound sealant over filler. ASTM C920, Uses M and A, single component, mildew resistant. Sanded to match grout. Provide at all wall corners, ceilings, control joints and changes in materials, where floor tile abuts perimeter walls, curbs, columns, and pipes; and 24 feet to 36 feet elsewhere.
  3. Conditions exposed to chemicals, food processing, etc.: Polysulfide sealant over filler. ASTM C920, Grade P, Class 25, Uses T and M. Polyspec Thiokol, or Architect approved equal. Self-leveling and flexible sealant over filler of type instructed by manufacturer to suit application. Sealant shall match grout color. Expansion joints shall conform to TCA EJ171.

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- F. Latex Floor Leveling Material: ARDEX K-15 Self-Leveling Underlayment Concrete manufactured by ARDEX; (724) 203-5000 or comparable product approved by Architect.
- G. Edge Protection and Transition Strips:
  - 1. Porcelain Tile to Gyp. Bd.: Schluter® - Jolly transition strips in stainless steel finish at all porcelain tile wainscot to gyp board transition locations.
  - 2. Porcelain Tile to LVT: Schluter® - RENO-U edge protection in stainless steel finish at porcelain tile to sealed concrete.
  - 3. Approved Manufacturer: Schluter® Systems LP, Plattsburg, NY; (800) 472-4588.
  - 4. Provide all corners and connectors as required for a complete and detailed finished installation.

## 2.3 EXTRA TILE

- A. Deliver 3% extra tile (minimum one box) of each color tile and base from the same tile production run to the Owner at Substantial Completion.

## PART 3 EXECUTION

### 3.1 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.
- B. Contractor is required to achieve the specified concrete moisture content prior to installation of all flooring materials or use a flooring manufacture approved moisture barrier prior to installation of all flooring products.
- C. Maintain temperatures at 50 degrees F or more in tiled areas during installation and for 7 days after completion, unless higher temperatures are required by referenced installation standard or manufacturer's instructions.

### 3.2 EXTRA MATERIALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents:
  - 1. Tile and Trim Units: Furnish quantity of full size units equal to 3 percent (one box minimum) of amount installed for each type, composition, color, pattern, and size indicated.
  - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

### 3.3 PREPARATION

- A. By General Contractor:
  - 1. Protect surrounding work from damage or disfiguration.
  - 2. Vacuum clean and damp clean existing substrate surfaces.
- B. By Tile Contractor:
  - 1. Examine preparatory work by others and notify Architect of any imperfections which would affect a satisfactory completion of this tile work.
  - 2. Examine substrates defects which may affect the work. Do not start work until defects have been corrected. Ensure that surfaces are:

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- a. Free of cracks, dry, clean, free of oily or waxy films, free of curing compounds.
- b. Well cured, firm and level within TCA specified tolerances.
- c. Minimum of 40 degrees F and rising.

C. Absence of such notification shall constitute acceptance of responsibility by tile contractor.

### **3.4 INSTALLATION**

- A. Crack Isolation Membrane:
  1. Install crack isolation membrane under tile over building control joints and substrate cracks up to 1/8 inch. Apply a 30 inch wide strip centered on control joint or crack. Install in accordance with TCA F125 and manufacturer's instructions. If Alternate No. is accepted polyethylene membrane shall be installed over entire floor area to receive pavers.
  2. Install joint sealant in joint of first tile on both sides of control joint and crack.
  3. Install membrane with products or methods approved by membrane manufacturer when joining, sealing, fastening, or adhering sheet membranes.
- B. Install porcelain wall tile and porcelain pavers with aligned joints (no staggering), 1/8 inch to 3/16 inch joint width.
- C. Install porcelain pavers over crack isolation membrane in locations shown on drawings in accordance with TCA F125 and ANSI A108.5 recommendations and manufacturer's instructions.
- D. Do not use damaged porcelain tile, including those with broken or cracked edges.
- E. Lay out all work so that, where possible, no tiles less than half size occur.
- F. Install expansion joints in accordance with TCA publication EJ171. Install porcelain tile joints aligned with floor joints.
- G. Install grout in accordance with ANSI A108.10 and manufacturer's instructions.
- H. Install edge protection and transition strips in accordance with manufacturer's instructions.
- I. Damp cure grout in accordance with manufacturer's recommendations. Clean all porcelain tile surfaces upon completion. Protect finish porcelain tile work from damage.

### **3.5 CLEANING AND PROTECTION**

- A. Clean work at completion of installation, remove excess grout from porcelain tile surfaces. Wipe all tile with a clean damp cloth, and buff lightly, leaving tile surfaces clean and ready to use.
- B. Remove grout from adjacent finish surfaces.
- C. Protect finished installation until final acceptance.
- D. Do not permit traffic over finished floor surface.

### **3.6 REPAIR**

- A. Repair or replace damaged porcelain tile, including those with broken or cracked edges at no expense to Owner.

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**END OF SECTION 09 30 19**



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## **SECTION 09 51 00 ACOUSTICAL CEILING PANELS**

### **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 requirements including but not limited to:
  - 1. Acoustical panels.
  - 2. Concealed and exposed suspension systems for ceilings.
  - 3. Accessories necessary for a complete installation.

#### **1.3 SUBMITTALS**

- A. Product Data: Technical data for each product including installation instructions.
- B. Samples:
  - 1. Acoustic Panel: Set of 6 inch (150 mm) square samples of each type, color, pattern, and texture.
  - 2. Exposed Suspension System Members, Moldings, and Trim: Set of 12 inch (300 mm) long samples of each type, finish, and color.
- C. Coordination Drawings:
  - 1. 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:
    - a. Suspended ceiling components.
    - b. Structural members to which suspension systems will be attached.
    - c. Size and location of initial access modules for acoustical panels.
    - d. Items penetrating finished ceiling including but not limited to the following:
      - 1) Lighting fixtures.
      - 2) Air outlets and inlets.
      - 3) Speakers.
      - 4) Sprinklers.
      - 5) Access panels.
    - e. Perimeter moldings.
- D. Maintenance Data: Manufacturer data for finishes for inclusion in maintenance manuals.
- E. Submit one copy of ICC-ES Reports.

#### **1.4 QUALITY ASSURANCE**

- A. Regulatory Requirements:
  - 1. Building Code:
    - a. Comply with applicable requirements of the CBC for interior finishes:
      - 1) DSA Interpretation of Regulations – IR 25-2.13 Metal Suspension Systems for Lay-in Panel Ceilings.
      - 2) CBC – 2019 California Building Code.
      - 3) Chapter 19, 2019 California Building Code.
      - 4) Chapter 23, 2019 California Building Code.

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- 5) Acoustical Panel Standard: ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance:
    - a) Mounting Method for Measuring NRC: Plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface according to ASTM E 795.
  2. Surface Burning Characteristics:
    - a. Ceiling panels with surface burning characteristics complying with CBC and ASTM E 1264 for Class A materials determined by testing identical products in accordance with ASTM E 84:
      - 1) Flame Spread Index : 25 or less.
      - 2) Smoke Developed Index: 450 or less.
  3. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  4. Fire Resistance Ratings: Comply with ASTM E 119; testing by qualified testing agency. Identify products with appropriate markings of applicable testing agency. Indicate design designations from UL *Fire Resistance Directory* or from the listings of another qualified testing agency.
- B. Source Limitations:
1. Acoustical Ceiling Panel: Obtain each type through one source from a single manufacturer.
  2. Suspension System: Obtain each type through one source from a single manufacturer.
- C. Comply with applicable regulations regarding toxic and hazardous materials:
1. Coating Based Antimicrobial Treatment: Provide acoustical panels with face and back surfaces coated with antimicrobial treatment; and showing no mold or mildew growth when tested in accordance with ASTM D3273.
  2. Panel Based Antimicrobial Treatment: Provide acoustical panels manufactured with antimicrobial treatment in the panels.
- D. Pre-installation Conference: Conduct conference at site.

## 1.5 WARRANTY

- A. Standard Ceiling Panels: Warrant ceiling panels to be free from sagging, warping, shrinking, buckling, or delaminating as a result of manufacturing defects for a period of one (1) year from the date of Substantial Completion.
- B. Sag Resistant Ceiling Panels: warrant products to be free from sagging, warping, shrinking, buckling, or delaminating as a result of manufacturing defects for a period of ten (10) years from the date of Substantial Completion.
- C. Standard Suspension System: Suspension systems shall be warranted to be free from defects in material or factory workmanship and shall not incur 50 percent red rust as defined by ASTM B117 test procedures for a period of ten (10) years from the date of Substantial Completion.
- D. Suspension system / ceiling panels: Provide manufacturers standard 15 year warranty for suspension systems when used in combination with same manufacturers sag resistant ceiling panels. Ceiling panels to be free from sagging, warping, shrinking, buckling, or delaminating as a result of manufacturing defects. Suspension systems shall not incur 50 percent red rust as defined by ASTM B117 test during the period of the warranty, extra materials.

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## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension system components, and accessories to site in original, unopened packages and store in a fully enclosed, conditioned space protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, allow panels to attain room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Manufacturers are subject to compliance with requirements; provide ceiling panels and grid systems by one of the following:
  - 1. Concealed and Exposed Suspension Grid:
    - a. Armstrong World Industries, Inc.
    - b. CertainTeed Corporation.
    - c. Chicago Metallic; Rockfon (Roxul Inc.).
    - d. USG Interiors.
  - 2. Acoustical Ceiling Panel:
    - a. Armstrong World Industries, Inc.
    - b. CertainTeed Corporation.
    - c. USG Interiors.
  - 3. Molding and Edge Trim:
    - a. Armstrong World Industries, Inc.
    - b. CertainTeed Corp.
    - c. Chicago Metallic Corporation.
    - d. Fry Reglet Corporation.
    - e. USG Interiors, Inc.; Subsidiary of USG Corporation.
  - 4. Acoustical Sealant for Exposed and Concealed Joints:
    - a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
    - b. USG Corporation; SHEETROCK Acoustical Sealant.
  - 5. Acoustical Sealant for Concealed Joints:
    - a. Henkel Corporation; OSI Pro-Series SC-175 Acoustical Sound Sealant.
    - b. Pecora Corporation; AIS-919.
- B. Acoustical Panel Colors and Patterns:
  - 1. Match appearance characteristics indicated for each product type:
    - a. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

### 2.2 METAL SUSPENSION SYSTEM

- A. Metal Suspension System:
  - 1. Direct hung metal suspension systems of types, structural classifications, and finishes indicated complying with applicable requirements in ASTM C 635/C 635M:
    - a. High Humidity Finish:
      - 1) Comply with ASTM C 635/C 635M requirements for Coating Classification for

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- Severe Environment Performance where high humidity finishes are indicated.
- b. Attachment Devices - Size for five times the design load indicated in ASTM C 635/C 635M, Table 1 Direct Hung, unless otherwise indicated. Comply with seismic design requirements:
  2. Wire Hangers, Braces, and Ties:
    - a. Zinc Coated, Carbon Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
    - b. Stainless Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
    - c. Nickel Copper Alloy Wire: ASTM B 164, nickel copper alloy UNS No. N04400.
    - d. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1 Direct Hung) will be less than yield stress of wire, but provide not less than 0.106 inch (2.69 mm) diameter wire.
  3. Hanger Rods and Flat Hangers: Mild steel, zinc coated or protected with rust inhibitive paint.
  4. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04 inch (1 mm) thick, galvanized steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16 inch (8 mm) diameter bolts.
  5. Hold Down Clips: Provide hold down clips spaced 24 inches (610 mm) o.c. on all cross tees in areas with exterior opening larger than 48" x 96".
  6. Impact Clips: Provide impact clip system designed to absorb impact forces against acoustical panels in Gymnasiums.
  7. Aluminum cap for use over steel grid in kitchen areas or where shown on drawings or required.
- B. Metal Suspension Systems:
1. Basis of Design: Suprafine XL as manufactured by Armstrong World Industries
  2. Narrow Face, Steel Capped, Double Web, Steel Suspension System:
    - a. Main and cross runners roll formed from cold rolled steel sheet; pre-painted, electrolytically zinc coated, or hot dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation; with prefinished, cold rolled, 9/16 inch (15 mm) wide metal caps on flanges:
      - 1) Structural Classification: Heavy-duty system.
      - 2) Face Design: Flat, flush.
      - 3) Cap Finish: Color selected by Architect.

## 2.3 ACOUSTICAL PANELS

- A. Acoustic Panel:
1. Basis of Design Product: No. 1912 by Armstrong World Industries.
  2. Classification - Provide panels complying with ASTM E 1264 for type, form, and pattern:
    - a. Type and Form: Type III, mineral base with painted finish.
  3. Color: White.
  4. LR: Not less than 0.85.
  5. NRC: Not less than 0.70.
  6. CAC: Not less than **35**.
  7. Surface Color: White
  8. Surface Pattern: Fine Texture
  9. Edge/Joint Detail: Tegular
  10. Thickness: 3/4 inch (19 mm).
  11. Modular Size: 24 by 24 inches (610 by 610 mm).
  12. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to

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ASTM D 3274 or ASTM G 21.

B. Acoustic Panel Ceiling at Room 112 only.

A combination of two types of acoustic panels as listed below adhered to a single sheet of 5/8" thick type 'X' gypsum wall board to form a single high performance acoustic ceiling barrier.

Exposed to view acoustic panel

1. Basis of Design Product: No. 3155 Optima Open Plan by Armstrong World Industries.
2. Classification - Provide panels complying with ASTM E 1264 for type, form, and pattern:
  - b. Type and Form: Type XII, Form 2, Pattern E. Fiberglass with DuraBrite acoustically transparent membrane.
3. Color: White.
4. LR: Not less than 0.90.
5. NRC: Not less than 1.00.
6. Surface Color: White
7. Surface Pattern: Fine Texture
8. Edge/Joint Detail: Tegal
9. Thickness: 1 1/2 inch.
10. Modular Size: 24 by 24 inches (610 by 610 mm).
11. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

Gypsum Wall Board

1. Ceiling Type - Manufactured for sag resistance:
  - a. Thickness: 1/2 inch (13mm).
  - b. Long Edges: Tapered.

Concealed Acoustic Panel

1. Basis of Design Product: No. 99241 Halcyon ClimaPlus Panels by USG.
2. Classification - Provide panels complying with ASTM E 1264 for type, form, and pattern:
  - a. Type and Form: Type XII, Form 2, Pattern E & G. Fiberglass.
3. Color: White.
4. CAC: Not less than 25
5. LR: Not less than 0.88.
6. NRC: Not less than 1.00.
7. Surface Color: White
8. Surface Pattern: Fine Texture
9. Edge/Joint Detail: Tegal
10. Thickness: 1 1/2 inch.
11. Modular Size: 24 by 24 inches (610 by 610 mm).
12. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

## 2.4 MOLDING, TRIM AND ACCESSORIES

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- A. Shadow Molding: Where an acoustical lay in ceiling abuts a gypsum board ceiling in the same plane, provide a "W" shaped reveal or "shadow" molding similar to Armstrong Shadow Molding No. 7873.
- B. Light Fixture Protection:
  - 1. Manufacturer: Thermafiber Light Protection Kit by Owens Corning or Type 5/8 or 3/4 P(S) by Armstrong World Industries.
  - 2. Fire Resistance Rating: Same as ceiling assembly rating.
  - 3. Locations: At fixtures reinstalled in fire rated ceiling assemblies.
- C. Roll Formed, Sheet Metal Edge Moldings and Trim:
  - 1. Type and profile for standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color used for exposed flanges of suspension system runners:
    - a. Provide edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
    - b. For lay in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
    - c. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- D. Extruded Aluminum Edge Moldings and Trim:
  - 1. Where indicated, provide extruded aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
    - a. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 (ASTM B 221M) for Alloy and Temper 6063-T5.
    - b. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
    - c. Baked Enamel or Powder Coat Finish: Minimum dry film thickness of 1.5 mils (0.04 mm). Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
- E. Acoustical Sealant:
  - 1. Comply with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90:
    - a. Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant.
    - b. Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic rubber sealant.

## PART 3 EXECUTION

### 3.1 PROJECT CONDITIONS

- A. Environmental Limitations:
  - 1. Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use:
    - a. Pressurized Plenums: Operate ventilation system for not less than 48 hours before

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beginning acoustical panel ceiling installation.

### 3.2 EXTRA MATERIALS

- A. Furnish extra materials matching products installed and packaged with protective covering for storage and identified with labels describing contents:
  - 1. Acoustical Ceiling Panels: Full size panels equal to 2 percent of quantity installed.
  - 2. Suspension System Components: Quantity of each exposed component equal to 2 percent of quantity installed.
  - 3. Hold Down Clips: Equal to 2 percent of quantity installed.
  - 4. Impact Clips: Equal to 2 percent of quantity installed.

### 3.3 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut for compliance with requirements specified that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation after correcting unsatisfactory conditions.

### 3.4 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less than half width panels at borders, and comply with layout shown on reflected ceiling plans.

### 3.5 INSTALLATION

- A. Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and *CISCA Ceiling Systems Handbook*:
  - 1. Fire Rated Assembly: Install fire-rated ceiling systems according to tested fire rated design.
- B. Suspend ceiling hangers from building's structural members and as follows:
  - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
  - 2. Splay hangers where required and, if permitted with fire resistance rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
  - 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
  - 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure



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- and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast in place hanger inserts, postinstalled mechanical or adhesive anchors, or power actuated fasteners that extend through forms into concrete.
  7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
  8. Do not attach hangers to steel deck tabs.
  9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
  10. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
  11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast in place or postinstalled anchors.
- D. Panel Accessibility: Install panels downward accessible by disengaging hinge support rail on one side of panel from the T Bar Flange or optional A Mount rail flange without the use of tools, for access without removal of panel from the ceiling.
- E. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels:
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
  2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
  3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- F. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- G. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit:
1. Arrange directionally patterned acoustical panels with pattern running in one direction parallel to long axis of space.
  2. For square edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
  3. For reveal edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
  4. For reveal edged panels on suspension system members with box shaped flanges, install panels with reveal surfaces in firm contact with suspension system surfaces and panel faces flush with bottom face of runners.
  5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
  6. Install hold-down clips in areas indicated, in areas with exterior opening larger than 48" x 96", where required by authorities having jurisdiction, and for fire resistance ratings; space as recommended by panel manufacturer's written instructions unless otherwise



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indicated.

7. Install clean room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.
8. Protect lighting fixtures and air ducts to comply with requirements indicated for fire resistance rated assembly.

### **3.6 FIRE RATING SCHEDULE**

- A. Refer to UL Assemblies Drawings for Fire Rating requirements of ceiling materials at rated floor and roof assemblies.

### **3.7 FIELD QUALITY CONTROL**

- A. Special Inspections:
  1. Engage a qualified special inspector to perform the following special inspections:
    - a. Compliance of seismic design.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and prepare test reports.
- C. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations show compliance with requirements:
  1. Extent of Each Test Area:
    - a. When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed:
      - 1) Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
      - 2) When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
- D. Acoustical panel ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### **3.8 CLEANING**

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

**END OF SECTION 09 51 00**

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## **SECTION 09 65 13.13 RESILIENT BASE**

### **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 requirements including but not limited to:
  - 1. Rubber base.
  - 2. Accessories necessary for a complete installation.

#### **1.3 SUBMITTALS**

- A. Product Data: Technical data for each type of product including manufacturer's installation instructions.
- B. Samples: Sample of Base Selected or Color Chart if none selected.
- C. Maintenance Data: Submit for inclusion in maintenance manuals.

#### **1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: Entity having minimum 5 years documented experience who employs workers competent in techniques required by manufacturer for floor tile installation and seaming method indicated.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Store base and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 degrees F (10 degrees C) or more than 85 degrees F (29 degrees C). Store floor tiles on flat surfaces.

### **PART 2 PRODUCTS**

#### **2.1 MATERIALS**

- A. Basis of Design Product:
  - 1. Manufacturers and tile series, pattern, and color selections are indicated in the Finish Schedule and are a basis of design. Subject to compliance with requirements, provide product indicated in Finish Schedule or comparable product by one of the following:
    - a. Flexco Floors.
    - b. Johnsite, a division of Tarkett Group.
    - c. Mannington Commercial.
    - d. Roppe.
- B. Rubber Base - ASTM F1861:
  - 1. Material: Rubber, vulcanized, Type TS, Group I, Styles A and B.
  - 2. Manufacturing Method: Group I (solid, homogeneous).
  - 3. Style: Topset cove; minimum 100 foot coil, cut to length required.

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4. Minimum Thickness: 0.125 inch (3.2 mm).
  5. Color: Selected by Architect.
  6. Height: 4 inches, unless otherwise indicated on drawings.
  7. Outside Corners: Job formed.
  8. Inside Corners: Job formed.
- C. Adhesives: Water resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.

## **PART 3 EXECUTION**

### **3.1 FIELD CONDITIONS**

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 degrees F (21 degrees C) or more than 85 degrees F (29 degrees C), in spaces to receive floor tile during the following time periods:
1. 48 hours before installation.
  2. During installation.
  3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 degrees F (13 degrees C) or more than 95 degrees F (35 degrees C).
- C. Close spaces to traffic for 48 hours after installation.

### **3.2 EXAMINATION**

- A. Examine substrates for compliance with requirements for maximum moisture content and other conditions affecting performance of the work:
1. Verify that finishes of substrates comply with tolerances and other requirements specified for other work and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation after correcting unsatisfactory conditions. Installation of resilient flooring and accessories indicates acceptance of surfaces and conditions.

### **3.3 PREPARATION**

- A. Immediately before installation, sweep clean substrates to be covered by resilient base.

### **3.4 INSTALLATION**

- A. Comply with manufacturer's written instructions for installing flooring. Scribe and cut flooring to butt neatly and tightly to vertical surfaces, permanent fixtures, and built in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Extend flooring into toe spaces, door reveals, closets, and similar openings.
- B. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on flooring as marked on substrates. Use chalk or other nonpermanent marking device.
- C. Resilient Base:
1. Comply with manufacturer's written instructions for installing resilient base. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and

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other permanent fixtures in rooms and areas where base is required:

- a. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- b. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- c. Do not stretch resilient base during installation.
- d. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- e. Preformed Corners: Install preformed corners before installing straight pieces.
- f. Job Formed Corners:
  - 1) Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.
  - 2) Form without producing discoloration (whitening) at bends.
  - 3) Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length:
    - a) Miter or cope corners to minimize open joints.

**END OF SECTION 09 65 13.13**

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## **SECTION 09 65 23 LUXURY VINYL TILE FLOORING**

### **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 requirements limited to:
  - 1. Luxury vinyl floor tile.
  - 2. Accessories necessary for a complete installation.
- B. Related Sections:
  - 1. Section 03 30 00: Cast-In-Place Concrete.
  - 2. Section 09 65 13.13: Resilient Base.

#### **1.3 SUBMITTALS**

- A. Product Data: Technical data for each type of product including manufacturer's installation instructions.
- B. Shop Drawings - For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built in furniture, cabinets, and cutouts:
  - 1. Show details of special patterns.
- C. Samples - Full size units of each color and pattern of floor tile required:
  - 1. Luxury Vinyl Tile (LVT) flooring: 18 inch by 18 inch (460 mm by 460 mm) tile in each color selected and 12 inch long piece of base material in each color selected for approval.
- D. Product Schedule: Submit for floor tile using same designations indicated on Drawings.
- E. Maintenance Data: Submit for inclusion in maintenance manuals.
- F. Reports: Certified Moisture Testing Results.

#### **1.4 QUALITY ASSURANCE**

- A. Regulatory Requirements:
  - 1. Fire Test Response Characteristics - For resilient tile flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency:
    - a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
    - b. Smoke Density: Maximum specific optical density of 450 per ASTM E 662 or NFPA 258.
  - 2. Accessibility Requirements - Comply with applicable requirements:
    - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).
    - b. 2010 ADA regulations.
    - c. 2019 CBC Section 11B-302.1.

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- B. Installer Qualifications: Entity having minimum 5 years documented experience who employs workers competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
- C. Contractor is required to achieve the specified concrete moisture content prior to installation of all flooring materials or use a flooring manufacture approved moisture barrier prior to installation of all flooring products. Contractor shall provide certified moisture testing results per ASTM F2170 (*Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes*) to Architect and Owner prior to floor installation. Acceptable moisture content of concrete sub floor shall be within approved manufacture limits or lower prior to installation.
- D. Source Limitations:
  - 1. Tile: Obtain floor products of same type and color or finish from one source or producer. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.
  - 2. Setting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.

## 1.5 WARRANTY

- A. Warrant the Work specified herein for ten (10) years against becoming unserviceable or causing an objectionable appearance resulting from either defective, or nonconforming materials and workmanship.
- B. Defects shall include, but not be limited to, the following:
  - 1. Damaged tile, including broken or chipped edges.
  - 2. Loose or missing tile.
  - 3. Noticeable deterioration or discoloring of tile or grout.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 degrees F (10 degrees C) or more than 85 degrees F (29 degrees C). Store floor tiles on flat surfaces.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Basis of Design Product:
  - 1. Manufacturers and tile series, pattern, and color selections are indicated in the Finish Schedule and are a basis of design. Subject to compliance with requirements, provide product indicated in Finish Schedule or comparable product by one of the following:
    - a. Luxury Vinyl Tile (LVT):
      - 1) Basis of Design: Mannington Commercial, Collection Nature's Path - Abstract
      - 2) Alternates include:
        - a) Forbo
        - b) Armstrong.
        - c) Tandus Centiva.
        - d) Other comparable product.
- B. Luxury Solid Vinyl Tile - ASTM F 1700:

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1. Class I, monolithic vinyl tile:
    - a. Type A: Smooth surface.
  2. Thickness: 0.125 inch (3.2 mm).
  3. Size: 18"-inch x 36"-inch
  4. Construction: Heterogeneous Resilient Flooring with .030" (30 mil) high density wear layer.
  5. Color: Dissolve Recede by Mannington Commercial
- C. Trowelable Leveling and Patching Compounds: Latex modified, portland cement based formulation provided or approved by floor tile manufacturer for applications indicated.
- D. Adhesives: Water resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
- E. Acoustic Underlayment:
  1. Closed cell, polypropylens foam
  2. 2 mm minimum thickness
  3. IIC 71db delta IIC 25db
  4. STC 66db
- F. Floor Polish: Provide protective, liquid floor polish products recommended by floor tile manufacturer.

## **PART 3 EXECUTION**

### **3.1 FIELD CONDITIONS**

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 degrees F (21 degrees C) or more than 85 degrees F (29 degrees C), in spaces to receive floor tile during the following time periods:
  1. 48 hours before installation.
  2. During installation.
  3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 degrees F (13 degrees C) or more than 95 degrees F (35 degrees C).
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Where demountable partitions, cabinets, and similar items are indicated for installation on top of resilient tile flooring, install tile before these items are installed.
- F. Do not install flooring over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive, as determined by flooring manufacturer's recommended bond and moisture test.
- G. Install flooring after other finishing operations, including painting, have been completed.

### **3.2 EXTRA STOCK**

- A. Furnish extra materials matching products installed and packaged with protective covering for storage and identified with labels describing contents:

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1. LVT Flooring: 1 percent of quality installed or 2 full unopened containers, whichever is greater.

### 3.3 EXAMINATION

- A. Examine substrates for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work:
  1. Verify that finishes of substrates comply with tolerances and other requirements specified for other Work and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation after correcting unsatisfactory conditions. Installation of resilient flooring and accessories indicates acceptance of surfaces and conditions.

### 3.4 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates - Prepare according to ASTM F 710:
  1. Verify substrates are dry and free of curing compounds, sealers, and hardeners.
  2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
  3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
  4. Moisture Testing - Proceed with installation only after substrates pass testing according to floor tile manufacturer's written recommendations, but not less stringent than the following:
    - a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
    - b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum **95** percent relative humidity level.
  5. Bond Test: Bond 3' x 3' panels spaced 50 feet apart throughout subfloor area. After moisture test proves floor acceptably dry, install panels using adhesive. If panels are securely bonded after 72 hours, subfloor is sufficiently clean of foreign materials for satisfactory installation of resilient flooring.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Install underlayment per manufacturers recommendation.
- E. Do not install floor tiles until they are the same temperature as the space where they are to be installed:
  1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- F. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.



**3.5 INSTALLATION**

- A. Comply with manufacturer's written instructions for installing flooring. Scribe and cut flooring to butt neatly and tightly to vertical surfaces, permanent fixtures, and built in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Extend flooring into toe spaces, door reveals, closets, and similar openings.
- B. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on flooring as marked on substrates. Use chalk or other nonpermanent marking device.
- C. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one/half tile at perimeter:
  - 1. Lay tiles square with room axis.
- D. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles:
  - 1. Lay tiles with grain running in one direction.
- E. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built in furniture, cabinets, pipes, outlets, and door frames.
- F. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- H. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- I. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- J. Floor Tile - Comply with manufacturer's written instructions for installing floor tile:
  - 1. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one/half tile at perimeter:
    - a. Lay tiles square with room axis unless pattern indicated for an area.
  - 2. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles. Lay tiles with grain running in one direction.
- K. Resilient Accessories - Comply with manufacturer's written instructions for installing resilient accessories:
  - 1. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

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### **3.6 CLEANING AND PROTECTION**

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
  - 1. Remove adhesive and other blemishes from exposed surfaces.
  - 2. Sweep and vacuum surfaces thoroughly.
  - 3. Damp mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish. Apply two coat(s).
- E. Sealers and Finish Coats:
  - 1. Remove soil, visible adhesive, and surface blemishes from resilient terrazzo floor tile surfaces before applying liquid cleaners, sealers, and finish products:
    - a. Sealer: Apply two base coats of liquid sealer.
    - b. Finish: Apply two coats of liquid floor finish.
- F. Cover floor tile until Substantial Completion.
- G. Clean floor surfaces not more than 4 days before dates scheduled for inspections intended to establish date of Substantial Completion in each area of Project. Clean products according to manufacturer's written recommendations:
  - 1. Before cleaning, strip protective floor polish.
  - 2. Reapply polish to floor surfaces to restore protective floor finish according to flooring manufacturer's written recommendations.

**END OF SECTION 09 65 23**

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## **SECTION 09 68 00 CARPET TILE**

### **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 requirements including but not limited to:
  - 1. Carpet.
  - 2. Accessories necessary for a complete installation.
- B. Related Sections:
  - 1. Section 03 30 00: Cast-in-Place Concrete.
  - 2. Section 09 65 23: Luxury Tile Flooring.
  - 3. Section 09 68 01: Carpeting Walk-off Mats.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Pursuant to CBC Sections 11B-302.2 and 11B-303:
  - 1. Carpet shall be securely attached and shall have a firm, or no, cushion, pad, or backing. It shall have a textured pattern loop. Pile height shall be .140 inches maximum.
  - 2. Exposed edges shall be fastened to floor surfaces and shall have trim on the entire length.

#### **1.4 SUBMITTALS**

- A. Product Data - Technical data including installation recommendations for each type of substrate:
  - 1. Carpet: For each type indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
- B. Samples - For product selected. Label sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules:
  - 1. Carpet: 12 inch (300 mm) square Sample from approved color and product of carpet.
  - 2. Exposed Edge, Transition, and Other Accessory Stripping: 12 inch (300 mm) long Samples.
  - 3. Carpet base and accessory samples.
- C. Product Test Reports: For carpet and carpet cushion, for tests performed by a qualified testing agency.
- D. Shop Drawings: Showing extent of product, seam direction, and location and type of carpet accessories. Submittal to indicate columns, doorways, enclosing walls or partitions, casework, and locations where cutouts are required.
- E. Maintenance Data - For carpet to include in maintenance manuals. Include the following:
  - 1. Methods for maintaining carpet, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
  - 2. Precautions for cleaning materials and methods that could be detrimental to carpet and

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carpet cushion.

## 1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - Fire Test Response Characteristics: Provide products with the critical radiant flux classification determined by testing identical products in accordance with ASTM E 648.
  - Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
  - Smoke Chamber: Less than 450 (flaming mode) per ASTM E-662
- 1. Accessibility Requirements - Comply with applicable requirements:
  - a. Americans with Disabilities Act of 1990, as amended:
    - 1) ADA Title II Regulations & the 2010 ADA Standards for Accessible Design
    - 2) 2010 ADA regulations.
  - b. CBC 2019 California Building Code (CCR Title 24, Part 2, as adopted and amended by DSA):
    - 1) CBC Chapter 11B, Access to Public Buildings, Public Accommodations, Commercial Buildings and Public Housing.
- 2. AQMD - Air Quality Management District, Local Regulations.
- 3. SCAQMD – South Coast Air Quality Management District Regulations Rule 1168 Adhesive and Sealant Applications.
- 4. CRI – Carpet and Rug Institute Green Label Plus.
- 5. Carpet shall have level loop, textured loop, or level-cut/uncutpile texture, firm cushion, pad or backing (or no cushion or pad) and maximum pile height of 1/2 inch in accordance with CBC Section 11B-302.2. Carpet edges shall comply with CBC 11B-302.2 and carpet trim to CBC Section 11B-303.
- B. Installer Qualifications: Installer having minimum 5 years' documented experience as a commercial carpet installer, who is certified by the International Certified Floorcovering Installers Association at the Commercial II or higher certification level.
- C. Contractor is required to achieve the specified concrete moisture content prior to installation of all flooring materials or use a flooring manufacture approved moisture barrier prior to installation of all flooring products.
- D. Pre-installation Conference:
  - 1. Refer to Section 01 31 00: Project Management and Coordination.

## 1.6 WARRANTY

- A. Written warranty in which manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period:
  - 1. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
  - 2. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, failure of moisture barrier, dimensional stability, excessive surface wear, excess static discharge, and delamination.
  - 3. Warranty Period: 15 years from date of Substantial Completion.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104.
- B. Store in a dry location between 65 degrees F and 90 degrees F and a relative humidity below 65%. Protect from damage and soiling. Stack carpet rolls horizontally, elevated

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above slab level on a flat surface, stacked no higher than two rolls.

- C. Store materials in area of installation for minimum period of 48 hours prior to installation.
- D. Protect carpet from damage, dirt, stains, and moisture.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- A. Carpet, Backing and Pad:
  - 1. Manufacturer: Mannington Commercial
  - 2. Carpet Type 1:
    - a. Collection: Entwined
    - b. Style: Ramie
    - c. Color: Carob (12336)
  - 3. Backing: Integra HP Backing
- B. Applied Soil Resistance Treatment: Standard with manufacturer.
- C. Fiber Face: Invista Antron Legacy Type 6.6, four hole, hollow filament nylon
- D. Dye Method: Solution /yarn
- E. Tufted Yarn Weight: 22 ounces per square yard
- F. Standard Tile Size: 24" x 24" modular tiles
- G. Antimicrobial Treatment: Standard with manufacturer.
- H. Seam Sealer/weld: MT800 Seam Sealer by Mannington
- I. Adhesives: Water resistant, mildew resistant, nonstaining, pressure sensitive type to suit products and subfloor conditions indicated, complying with flammability requirements for installed carpet and is recommended by carpet manufacturer for releasable installation.
  - 1. Integra Adhesive by Mannington
- J. Trowelable Leveling and Patching Compounds: Latex modified, hydraulic cement based formulation provided or recommended by carpet cushion manufacturer.
- K. Metal Edge/Transition Strips: Extruded aluminum with mill finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.
- L. Extra Carpet: After completion of the carpet installation, the carpet subcontractor shall provide an additional three (3) percent of total yards installed of each carpet specified to the Owner for future carpet replacement that may be required. This extra stock is to be unused boxed tiles and does not include scraps.

## **PART 3 EXECUTION**

### **3.1 FIELD CONDITIONS**

- A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.

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- B. Environmental Limitations: Do not deliver or install carpet and carpet cushion until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.
- C. Do not install carpet and carpet cushion over concrete slabs until slabs have cured, are sufficiently dry to bond with adhesive, and have pH range recommended by carpet manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.

### 3.2 COORDINATION

- A. Contractor's responsibility to hire movers to move furniture as required for flooring installation. Coordinate with Owner and Architect regarding temporary furniture relocation.

### 3.3 EXAMINATION

- A. Examine substrates, areas, and conditions for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance. Examine carpet for type, color, pattern, and potential defects.
- B. Concrete Subfloors -Verify that concrete slabs comply with ASTM F 710 and the following:
  1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond.
  2. Prior to delivery of flooring materials, contractor shall conduct Calcium Chloride "dome" test to verify that concrete floors are dry with maximum moisture vapor emissions of 3 lbs. per 1000 square feet. in 24 hours, and exhibit negative alkalinity, carbonation or dusting. Apply moisture test in four (4) different areas of each floor location with at least one test for each 1,000 square feet of floor area.
  3. Prior to delivery of carpeting, conduct Relative Humidity Test Method in accordance with ASTM F 2170 using a Wagner Rapid RH probe to verify relative humidity and surface pH of concrete floor slabs, the method:
    - a. Requires drilling holes at diameter not to exceed outside diameter of probe by more than 0.04 inch to depth equal to 40 percent of slab's thickness (elevated structural slab shall be tested at depth equal to 20 percent of slab thickness).
    - b. Place probe to full depth of test hole, place cap over probe.
    - c. Permit test site to acclimate, or equilibrate, for 72 hours prior to taking relative humidity readings.
    - d. Remove cap and press button on the probe to obtain reading.
    - e. Relative humidity readings for substrates receiving non-permeable flooring are 75% or lower.
  4. Testing shall require 3 tests in first 1,000 square feet, with one additional test per each additional 1,000 square feet of concrete slab surface.
  5. Alkalinity Testing: Concrete floors shall be tested for alkalinity prior to installation of flooring. Levels of pH shall not exceed written recommendations of flooring manufacturer or adhesive manufacturer, or both.
  6. Delivery of flooring materials and beginning of installation means acceptance of existing substrate and site conditions.
  7. Subfloor finishes comply with requirements specified in Section 03 30 00: Cast-In-Place Concrete for slabs receiving carpet.
  8. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
  9. Install Vapor Emission Treatment Systems where tests reveal presence of more than acceptable moisture level in accordance with Test Method ASTM F 1869 or ASTM F 2170.

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- C. Proceed with installation after correcting unsatisfactory conditions.

### 3.4 PREPARATION

- A. Comply with CRI 104, Section 7.3 *Site Conditions; Floor Preparation* and with carpet manufacturer's written installation instructions for preparing substrates.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm), unless more stringent requirements are required by manufacturer's written instructions.
- C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet and cushion manufacturer.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

### 3.5 INSTALLATION

- A. Comply with CRI 104 and carpet manufacturer written installation instructions for the following:
  - 1. Direct Glue Down Installation: Comply with CRI 104, Section 9 *Direct Glue Down Installation*.
  - 2. Stair Installation: Comply with CRI 104, Section 13 *Carpet on Stairs* for glue down installation.
- B. Comply with carpet manufacturer's written recommendations and Shop Drawings direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position:
  - 1. Do not bridge building expansion joints with carpet.
  - 2. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.
  - 3. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- C. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- D. Install pattern parallel to walls and borders to comply with CRI 104, Section 15, *Patterned Carpet Installations* and with carpet manufacturer's written recommendations.
- E. Install in accordance with CBC Section 11B-302.2

### 3.6 CLEANING AND PROTECTING

- A. Perform cleaning operations immediately after installing carpet:
  - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
  - 2. Remove yarns that protrude from carpet surface.
  - 3. Vacuum carpet using commercial machine with face beater element.

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- B. Protect installed carpet to comply with CRI 104, Section 16, *Protecting Indoor Installations*.
- C. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet manufacturer and carpet cushion manufacturer

**END OF SECTION 09 68 00**



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## **SECTION 09 68 01 CARPETING WALK-OFF-MATS**

### **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 requirements including but not limited to:
  - 1. Walk Off Carpet.
  - 2. Accessories necessary for a complete installation.
- B. Related Sections:
  - 1. Section 03 30 00: Cast-in-Place Concrete.
  - 2. Section 09 68 00: Carpeting.

#### **1.3 SUBMITTALS**

- A. Product Data:
  - 1. Technical data including installation recommendations for each type of substrate:
    - a. Carpet:
      - 1) For each type indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
- B. Samples:
  - 1. For each products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules:
    - a. Carpet: 12 inch (300 mm) square Sample from approved color and product of carpet.
    - b. Exposed Edge, Transition, and Other Accessory Stripping: 12 inch (300 mm) long Samples.
    - c. Mitered Carpet Border Seam: 12 inch (300 mm) square Sample. Show carpet pattern alignment.
    - d. Carpet base and accessory samples.
- C. Product Test Reports: For carpet and carpet cushion, for tests performed by a qualified testing agency.
- D. Shop Drawings: Showing extent of product, seam direction, and location and type of carpet accessories. Submittal to indicate columns, doorways, enclosing walls or partitions, casework, and locations where cutouts are required.
- E. Maintenance Data:
  - 1. For carpet to include in maintenance manuals. Include the following:
    - a. Methods for maintaining carpet, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
    - b. Precautions for cleaning materials and methods that could be detrimental to carpet and carpet cushion.

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## 1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Fire Test Response Characteristics:
    - a. Provide products with the critical radiant flux classification determined by testing identical products in accordance with ASTM E 648:
      - 1) Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
  - 2. Accessibility Requirements:
    - a. Comply with applicable requirements:
      - 1) Americans with Disabilities Act of 1990, as amended:
        - a) ADA Title II Regulations & the 2010 ADA Standards for Accessible Design.
        - b) 2010 ADA regulations.
      - 2) CBC 2019 California Building Code (CCR Title 24, Part 2, as adopted and amended by DSA):
        - a) CBC Chapter 11B, Access to Public Buildings, Public Accommodations, Commercial Buildings and Public Housing.
  - 3. AQMD - Air Quality Management District, Local Regulations.
  - 4. SCAQMD – South Coast Air Quality Management District Regulations Rule 1168 Adhesive and Sealant Applications.
  - 5. CRI – Carpet and Rug Institute Green Label Plus.
  - 6. Carpet shall have level loop, textured loop, or level-cut/uncutpile texture, firm cushion, pad or backing (or no cushion or pad) and maximum pile height of 1/2 inch in accordance with CBC Section 11B-302.2. Carpet edges shall comply with CBC 11B-302.2 and carpet trim to CBC Section 11B-303.
- B. Installer Qualifications: Installer having minimum 5 years documented experience as a commercial carpet installer, who is certified by the International Certified Floorcovering Installers Association at the Commercial II or higher certification level.
- C. Contractor is required to achieve the specified concrete moisture content prior to installation of all flooring materials or use a flooring manufacture approved moisture barrier prior to installation of all flooring products.
- D. Pre-installation Conference:
  - 1. Pre-Installation conference to be conducted at project site.

## 1.5 WARRANTY

- A. Written warranty in which manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period:
  - 1. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
  - 2. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, dimensional stability, excessive surface wear, excess static discharge, and delamination.
  - 3. Warranty Period: 25 years from date of Substantial Completion.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104.
- B. Store in a dry location between 65 degrees F and 90 degrees F and a relative humidity below 65%. Protect from damage and soiling. Stack carpet rolls horizontally, elevated above slab level on a flat surface, stacked no higher than two rolls.

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- C. Store materials in area of installation for minimum period of 48 hours prior to installation.
- D. Protect carpet from damage, dirt, stains, and moisture.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- A. Carpet (Walk-Off):
  - 1. Type: 6,6 Nylon
  - 2. Collection: Frixton
  - 3. Style: Force
  - 4. Color: Static (34365)
  - 5. Secondary Back: Infinity Modular
  - 6. Locations: As shown on Drawings.
  - 7. Manufacturer: Mannington Commercial
- B. Applied Soil Resistance Treatment: Standard with manufacturer.
- C. Antimicrobial Treatment: Standard with manufacturer.
- D. Adhesives: Water resistant, mildew resistant, nonstaining, pressure sensitive type to suit products and subfloor conditions indicated, complying with flammability requirements for installed carpet and is recommended by carpet manufacturer for releasable installation.
- E. Trowelable Leveling and Patching Compounds: Latex modified, hydraulic cement based formulation provided or recommended by carpet cushion manufacturer.
- F. Adhesives: Water resistant, mildew resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended or provided by carpet and carpet cushion manufacturers.
- G. Extra Carpet: After completion of the carpet installation, the carpet subcontractor shall provide an additional three (3) percent of total yards installed of each carpet specified to the Owner for future carpet replacement that may be required. This extra stock is to be unused rolls, tiles, and mats and does not include scraps.

## **PART 3 EXECUTION**

### **3.1 FIELD CONDITIONS**

- A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet and carpet cushion until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.
- C. Do not install carpet and carpet cushion over concrete slabs until slabs have cured, are sufficiently dry to bond with adhesive, and have pH range recommended by carpet manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet,

install carpet before installing these items.

### 3.2 EXAMINATION

- A. Examine substrates, areas, and conditions for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance. Examine carpet for type, color, pattern, and potential defects.
- B. Concrete Subfloors:
  - 1. Verify that concrete slabs comply with ASTM F 710 and the following:
    - a. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond.
    - b. Prior to delivery of flooring materials, contractor shall conduct Calcium Chloride "dome" test to verify that concrete floors are dry with maximum moisture vapor emissions of 3 lbs. per 1000 square feet. in 24 hours, and exhibit negative alkalinity, carbonation or dusting. Apply moisture test in four (4) different areas of each floor location with at least one test for each 1,000 square feet of floor area.
    - c. Prior to delivery of carpeting, conduct Relative Humidity Test Method in accordance with ASTM F 2170 using a Wagner Rapid RH probe to verify relative humidity and surface pH of concrete floor slabs, the method:
      - 1) Requires drilling holes at diameter not to exceed outside diameter of probe by more than 0.04 inch to depth equal to 40 percent of slab's thickness (elevated structural slab shall be tested at depth equal to 20 percent of slab thickness).
      - 2) Place probe to full depth of test hole, place cap over probe.
      - 3) Permit test site to acclimate, or equilibrate, for 72 hours prior to taking relative humidity readings.
      - 4) Remove cap and press button on the probe to obtain reading.
      - 5) Relative humidity readings for substrates receiving non-permeable flooring are 75% or lower.
    - d. Testing shall require 3 tests in first 1,000 square feet, with one additional test per each additional 1,000 square feet of concrete slab surface.
    - e. Alkalinity Testing: Concrete floors shall be tested for alkalinity prior to installation of flooring. Levels of pH shall not exceed written recommendations of flooring manufacturer or adhesive manufacturer, or both.
    - f. Delivery of flooring materials and beginning of installation means acceptance of existing substrate and site conditions.
    - g. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
    - h. Install Vapor Emission Treatment Systems where tests reveal presence of more than acceptable moisture level in accordance with Test Method ASTM F 1869 or ASTM F 2170.
- C. Proceed with installation after correcting unsatisfactory conditions.

### 3.3 PREPARATION

- A. Comply with CRI 104, Section 7.3 *Site Conditions; Floor Preparation* and with carpet manufacturer's written installation instructions for preparing substrates.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm), unless more stringent requirements are required by manufacturer's written instructions.

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- C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet and cushion manufacturer.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

### 3.4 INSTALLATION

- A. Comply with CRI 104 and carpet and carpet cushion manufacturer written installation instructions for the following:
  - 1. Direct Glue Down Installation: Comply with CRI 104, Section 9 *Direct Glue Down Installation*.
- B. Comply with carpet manufacturer's written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position:
  - 1. Do not bridge building expansion joints with carpet.
  - 2. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.
  - 3. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- C. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- D. Install pattern parallel to walls and borders to comply with CRI 104, Section 15, *Patterned Carpet Installations* and with carpet manufacturer's written recommendations.
- E. Install in accordance with CBC Section 11B-302.2

### 3.5 CLEANING AND PROTECTING

- A. Perform cleaning operations immediately after installing carpet:
  - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
  - 2. Remove yarns that protrude from carpet surface.
  - 3. Vacuum carpet using commercial machine with face beater element.
- B. Protect installed carpet to comply with CRI 104, Section 16, *Protecting Indoor Installations*.
- C. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet manufacturer and carpet cushion manufacturer.

**END OF SECTION 09 68 01**

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## **SECTION 09 90 00 PAINTING AND COATING**

### **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 requirements including but not limited to:
  - 1. Surface preparation and field painting of exposed items and surfaces.
  - 2. Field preparation and painting of factory primed metal products and fabrications.
  - 3. Accessories necessary for a complete installation.
- B. Related Sections (Including but not limited to):
  - 1. Section 05 50 00: Metal Fabrications.
  - 2. Section 06 10 00: Rough Carpentry.
  - 3. Section 08 11 13: Hollow Metal Doors and Frames.
  - 4. Section 09 21 16: Gypsum Board Assemblies.

#### **1.3 DEFINITIONS**

- A. Standard coating terms defined in ASTM D 16 apply:
  - 1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85 degree meter.
  - 2. Eggshell refers to low sheen finish with a gloss range between 20 and 35 when measured at a 60 degree meter.
  - 3. Semigloss refers to medium sheen finish with a gloss range between 35 and 70 when measured at a 60 degree meter.
  - 4. Full gloss refers to high sheen finish with a gloss range more than 70 when measured at a 60 degree meter.

#### **1.4 SUBMITTALS**

- A. Product Data:
  - 1. Submit technical data and information for block fillers, primers, paints, and coatings, including label analysis and instructions for handling, storing, and applying each coating material proposed for use:
    - a. Indicate manufacturer's instructions for special surface preparation procedures, substrate conditions requiring special attention.
    - b. Material List: Provide inclusive list of required coating materials. Indicate each material and cross reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number, series, and general classification.
- B. Samples:
  - 1. Submit for each type of paint system and in each color and gloss of topcoat:
    - a. Provide stepped samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing samples for review. Resubmit until required sheen, color, and texture are achieved.
    - b. Provide list of material and application for each coat of each sample. Label each

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- sample as to location and application.
- c. Submit samples on following substrates for review of color and texture only:
  - 1) Concrete: Provide two 4 inch square samples for each color and finish.
  - 2) Concrete Masonry: Provide two 4" x 8" samples of masonry, with mortar joint in the center, for each finish and color.
  - 3) Painted Wood: Provide two 12 inch square samples of each color and material on hardboard.
  - 4) Ferrous and Nonferrous Metals: Provide two 4 inch square samples of flat metal and two 8 inch long samples of solid metal for each color and finish.
- C. Product List: Submit list of including each paint system, color, and location of application. Use same product and location designations indicated in Finish Schedule.
- D. Coating Maintenance Manual: Upon conclusion of the project, the Contractor or paint manufacturer/supplier shall furnish a coating maintenance manual, such as Sherwin-Williams "Custodian Project Color and Product Information" report or equal. Manual shall include an Area Summary with Finish Schedule, Area Detail designating where each product/color/finish was used, product/color/finish was used, product data pages, Manual Safety Data sheets, care and cleaning instructions, touchup procedures, and color samples of each color and finish used.

## 1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Comply with Federal and local toxicity and air quality regulations and with Federal requirements on content of for heavy metals, including but not limited to, lead and mercury. Do not use solvents in paint products that contribute to air pollution.
  - 2. Comply with CARB suggested control measures using the Method 24 analysis, limiting VOC's content to those noted in ASTM 6886.
  - 3. Performance and Durability:
    - a. ASTM D 16 – "Standard Test Method for Load Testing Refractory Shapes at High Temperatures."
    - b. ASTM D 2486 – "Standard Test Method for Scrub Resistance of Interior Wall Paint."
    - c. ASTM D 2805 – "Standard Test Method for Hiding Power of Paints by Reflectometry."
    - d. ASTM D 4828 – "Standard Test Method for Practical Washability of Organic Coatings."
    - e. ASTM D 3363 – "Standard Test Method for Film Hardness by Pencil Test."
- B. Applicator Qualifications: A firm or individual having minimum 5 years documented experience in applying paints and coatings similar in material, design, and extent to those indicated.
- C. Source Limitations: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.

## 1.6 WARRANTY

- A. Written warranty signed by the manufacturer and the installer in which the manufacturer and installer agree to repair or replace paint and primers that fail within specified warranty period:
  - 1. Failures include, but are not limited to, the following:
    - a. Flaking or delamination of paint with the substrate.
    - b. Rust, scale, similar imperfections due to improper surface preparation.



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- c. Thinning or watering of paint beyond that considered acceptable of paint manufacturer.
- d. Failure to achieve dry film thickness (DFT) recommended by manufacturer for each coat in a paint system.
- e. Deterioration or loss of color of paint beyond normal weathering.
- 2. Warranty Period: One year from date of Substantial Completion.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well ventilated areas with ambient temperatures continuously maintained at not less than 45 degrees F (7 degrees C):
  - 1. Maintain containers in clean condition, free of foreign materials and residue.
  - 2. Remove rags and waste from storage areas daily.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Basis of Specifications: **Sherwin Williams** paints:
  - 1. Subject to compliance with requirements, provide first quality, 100% acrylic, commercial or industrial products of one of the specified manufacturers. Residential products are not permitted:
    - a. Proprietary Names:
      - 1) Paint Schedule is based on a single manufacturer for convenience with exception to the paint used in specific areas where specialized coatings are required (Refer to Drawings).
      - 2) Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that named products are required to the exclusion of comparable products of specified manufacturers.
      - 3) Furnish product technical data, including per cent solids by weight and volume: (Method 24 analysis)
        - a) VOC content limits and emissions data.
        - b) Certificates of performance for comparable paint products of specified manufacturer.
    - b. Paint Products:
      - 1) Sherwin-Williams Co.
      - 2) PPG Industries, Inc.
      - 3) Dulux
- B. Material Compatibility: Provide each paint system including block fillers, primers, and finish coats, that are compatible with one another and with substrates indicated under conditions of service and application, demonstrated by manufacturer based on testing and field experience.
- C. Material Quality: Provide manufacturer's best quality commercial paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint material containers not displaying manufacturer's product identification will not be acceptable. Residential quality paint products are not permitted.
- D. Chemical Components of Interior Paints and Coatings:
  - 1. Provide products complying with limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    - a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent



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- by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
- b. Restricted Components: Paints and coatings shall not contain components restricted by the EPA.
- E. Accessories: Materials not specifically indicated but required to achieve the finishes specified, of commercial quality.
- F. Patching Materials: Latex filler compatible with paint systems.
- G. Fastener Head Cover Materials: Latex filler.

## 2.2 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials:
  - 1. Owner reserves the right to invoke to engage the services of a qualified testing agency to sample paint materials:
    - a. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to site, samples may be taken at the site. Samples will be identified, sealed, and certified by testing agency.
    - b. Testing agency will perform tests for compliance with product requirements.
    - c. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

## PART 3 EXECUTION

### 3.1 FIELD CONDITIONS

- A. Apply waterborne paints when temperatures of surfaces to be painted and surrounding air are between 50 degrees F and 90 degrees F (10 degrees and 32 degrees C).
- B. Do not thin or add water to waterbased paints, including waterbased alkyds.
- C. Weather Conditions:
  - 1. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
  - 2. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 5 degrees F (3 degrees C) above dew point; or to damp or wet surfaces.
  - 3. Minimum Application Temperatures for Water based Paints: Between 50 degrees F (10 degrees C) and 90 degrees F (32 degrees C).
- D. Apply solvent thinned paints when temperatures of surfaces to be painted and surrounding air are between 45 degrees F. and 95 degrees F (7 degrees F and 35 degrees C):
  - 1. Minimum Application Temperature for Varnish Finishes: 65 degrees F (18 degrees C) for interior or exterior, unless required otherwise by manufacturer's instructions.
  - 2. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.

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- E. Provide lighting level of 80 foot candles (860lx) measured midheight at substrate surface.
- F. Labels: Do not paint over Underwriters Laboratories, Factory Mutual, other code required labels, or equipment name, identification, performance rating, or nomenclature plates.

### 3.2 EXTRA MATERIALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents:
  - 1. Paint: 2 percent, but not less than 1 gallon (3.8 L) of each material and color applied.

### 3.3 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for maximum moisture content and conditions affecting performance of the work.
- B. Test substrates after repairing and cleaning substrates but prior to application of paint and coatings:
  - 1. Maximum moisture content of substrates, when measured with an electronic moisture meter as follows:
    - a. Concrete: 12 percent.
    - b. Fiber Cement Board: 12 percent.
    - c. Masonry (Clay and CMUs): 12 percent.
    - d. Wood: 15 percent.
    - e. Gypsum Board: 12 percent.
    - f. Plaster: 12 percent.
  - 2. Test cementitious and plaster cement/stucco for alkalinity (pH).
- C. Gypsum Board Substrates: Verify joints are taped and finishing compound is sanded smooth.
- D. Plaster Substrates: Verify plaster has fully cured. Verify existing plaster is in good condition and can receive new paint coating.
- E. Spray Textured Ceiling Substrates: Verify surfaces are dry.
- F. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers:
  - 1. Verify previously painted surfaces can be stripped to bare substrate, repaired if necessary, and prepared to receive new paint system consisting of primer and two top coats at a minimum:
    - a. Note: If previously painted surfaces have failed to accept new paint systems, determine cause of failure and take corrective measures to ensure each surface accepts new paint system. Failure of new paint system is not permitted.
- G. Commence paint and coating application after correcting unsatisfactory conditions and surfaces are dry. Application of coating indicates applicator's acceptance of surfaces and conditions.

### 3.4 ITEMS TO RECEIVE PAINT

- A. Generally, all new items that are normally painted in any typical building, including but not limited to the following list:

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1. All ferrous metal
  2. All exterior galvanized metal
  3. All exterior wood
  4. All interior wood
  5. All prime coated hardware
  6. All exposed pipe, plumbing, ductwork, conduit, outlet boxes and electrical cabinets, excluding those located in mechanical rooms.
  7. All metal grilles, except aluminum, unless otherwise indicated.
  8. All exposed gypsum board surfaces, including all mechanical rooms.
  9. Miscellaneous other items which normally require painting or are scheduled to be painted.
  10. Consult plans, finish schedule, details and specifications for other trades as all items usually field painted or finish will be considered as part of the Contract.
  11. All exposed mechanical equipment and electrical equipment.
  12. Traffic lanes and parking spaces including fire lanes and crosswalks.
  13. Rolling doors.
  14. Bollards.
  15. Loose lintels.
  16. Refer to MEP specifications for additional items to receive paint.
- B. All work where a coat of material has been applied must be inspected and approved by Architect before application of succeeding specified coat, otherwise no credit for coat applied will be given. Notify Architect when a particular coat has been completed for inspection and approval. Apply coats of material in strict accordance with manufacturer's specifications except where requirements of these specifications are in excess of manufacturer's requirements. Paint all sight exposed pipe and plumbing only after all mechanical work and tests have been completed.

### 3.5 PREPARATION

- A. Coordination of Work:
1. Review work in which primers are provided to ensure compatibility of the total system for various substrates. Notify Architect of anticipated problems when using materials specified over substrates primed by others:
    - a. Preprimed Substrates: Inspect existing conditions in which primers are factory applied to ensure compatibility of the total system for each substrate. Notify Architect of anticipated problems when using the materials specified over factory primed or preprimed substrates.
    - b. Existing Painted Surfaces: Inspect previously painted surfaces to ensure compatibility of the existing paints with new paint system for each substrate. Notify Architect of anticipated problems.
    - c. Correct defects and clean surfaces affecting bond with paint system. Remove existing paints exhibiting loose surface defects showing signs of rust, scale, or delamination.
    - d. Seal marks which may bleed through surface finishes.
- B. Surface Preparation:
1. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified. Provide barrier coats over incompatible primers or remove and reprime. If removal is impractical or impossible because of size or weight of item, provide surface applied protection before surface preparation and painting:
    - a. Remove hardware and hardware accessories, plates, lighting fixtures, and similar items that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface applied protection before surface

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- preparation and painting. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
  - b. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface applied protection if any.
  - c. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  - d. Clean and prepare surfaces to receive paint according to manufacturer's written instructions for each substrate condition and as specified. Provide barrier coats over incompatible primers, existing paint or coating, or remove and reprime.
  - e. Correct defects and clean surfaces affecting bond with paint or coating system. Remove existing coatings exhibiting loose surface defects. Seal marks which may bleed through surface finishes.
- C. Cleaning:
  - 1. Before applying paint or surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning. Schedule cleaning and painting so dust and contaminants from the cleaning process will not fall on wet, newly painted surfaces:
    - a. Remove incompatible primers, including factory applied primers, and reprime substrate with compatible primers or apply barrier coat as necessary to produce paint systems indicated.
    - b. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
    - c. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
    - d. Galvanized Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
    - e. Aluminum Substrates: Remove surface oxidation.
- D. Mildew and Mold Removal: Remove mildew and mold by high power washing (pressure range of 1500 to 4000 psi) with solution of trisodium phosphate and bleach. If substrate is too soft for high power washing, scrub substrate with solution. Rinse with clean water and allow surface to dry.
- E. Protective Coverings: Provide protections for duration of the work, including covering furnishings and decorative items. Protect and mask adjacent finishes and components against damage, marking, overpainting, and injury. Clean and repair or replace damage caused by painting.
- F. Renovated Surfaces:
  - 1. Clean surface free of loose dirt and dust. Except at gypsum board surfaces, remove existing paint and coatings to bare substrate and prepare substrates to receive new paint system. Test substrate to verify it will bond with primer and receive new paint system without failure. If test fails, clean surface to base substrate and apply barrier coat. Retest to verify surface will accept new paint system:
    - a. Remove surface film preventing proper adhesion and bond.
    - b. Wash glossy paint with a solution of sal soda and rinse thoroughly.
    - c. Remove loose, blistered, and defective paint and varnish; smooth edges with sandpaper.
    - d. Clean corroded iron and steel surfaces.
    - e. Repair and blend into portland cement plaster.
    - f. Prime bare surfaces.
    - g. Tone varnished surfaces with stain bringing to uniform color.

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- h. If existing surfaces cannot be put in acceptable condition for finishing by customary cleaning, sanding, and puttying operations, notify Owner and do not proceed until correcting unsatisfactory conditions.
- G. Cementitious Substrates:
- 1. Prepare concrete surfaces to receive paint. Remove efflorescence, chalk, dust, dirt, grease, oils, release agents, mold, mildew, and existing paint. Roughen as necessary to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation:
    - a. Use abrasive blast cleaning methods if recommended by paint manufacturer.
    - b. Do not paint surfaces if moisture content or alkalinity of surfaces exceeds that permitted in manufacturer's written instructions:
      - 1) Determine alkalinity and moisture content of surfaces by performing appropriate pH testing. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct condition prior to application of paint.
      - 2) Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m).
      - 3) Relative Humidity Test: Using in situ probes, ASTM F 2170. Proceed with installation after substrates have obtained percent relative humidity level recommended by paint manufacturer.
      - 4) Perform additional moisture tests when recommended by manufacturer. Proceed with installation when moisture content complies with that permitted in manufacturer's written instructions.
      - 5) Remove stains caused by weathering of corroding metals with solution of sodium metasilicate after thoroughly wetting with water. Allow to thoroughly dry.
  - 2. Clean concrete floors to receive paint or coating with a 5 percent solution of muriatic acid or etching cleaner. Flush floors with clean water to remove acid; neutralize with ammonia, rinse, allow to dry; vacuum before painting.
- H. Ferrous Metals:
- 1. Clean ungalvanized ferrous metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC recommendations:
    - a. Blast steel surfaces clean as recommended by paint system manufacturer and according to SSPC-SP 6/NACE No. 3.
    - b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
    - c. Touch up bare areas and shop-applied prime coats that have been damaged. Wire brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as the shop coat.
- I. Galvanized Ferrous Metal Substrates: Clean galvanized surfaces with nonpetroleum based solvents leaving surface free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- J. Shop Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop primed surfaces.
- K. Aluminum Substrates: Clean surfaces to remove oil, grease, surface oxidation, and contaminants in accordance with SSPC SP-1 Solvent Cleaning. Lightly abrade surface with

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a nonmetallic pad.

- L. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- M. Plaster/Stucco Substrates:
  - 1. Remove contaminants, release agents, curing compounds, efflorescence, chalk, mold, mildew, and similar deterrents. Spot patch existing plaster to eliminate blisters, buckles, excessive crazing, and to check cracking, dryouts, efflorescence, sweat outs, and similar defects the prevent plaster from bonding with paint or coatings. Sand or texture repair or patch to match adjacent finish and to remove trowel marks and arises:
    - a. Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.
    - b. Deep Cracks: Clean out and fill deep cracks with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.
    - c. Do not paint surfaces if moisture content or alkalinity of surfaces exceeds that permitted in manufacturer's written instructions. Test for alkali using litmus paper.
    - d. Allow patching and repair compounds to set and cure before painting.
- N. Gypsum Board Surfaces: Fill minor defects with filler compound. Spot prime defects after repair.
- O. Wood Substrates:
  - 1. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
  - 2. Sand surfaces that will be exposed to view, and dust off.
  - 3. Prime, stain, or seal wood to be painted. Prime edges, ends, faces, undersides, and back sides of wood, including cabinets, counters, cases, and paneling.
  - 4. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.
  - 5. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- P. Pipe Covering and Insulation: Clean to remove loose, foreign, and objectionable material before applying sealing coat.
- Q. Preparation of Substrates for Wallcovering:
  - 1. Prime and seal substrate with release coat in accordance with wallcovering manufacturer's recommendations for substrate:
    - a. Assure compatibility with product of wall covering manufacturer.
    - b. Fill indentations in substrate and prime with opaque white primer before applying release coat.
    - c. Apply release coat in accordance with manufacturer's recommendations.
- R. Barrier Coat: Provide barrier coats over incompatible primers or remove and reprime. Notify Owner in writing of anticipated problems using specified finish coat material over previously coated substrates.
- S. Material Preparation:
  - 1. Mix and prepare paint materials according to manufacturer's written instructions:
    - a. Maintain containers used in mixing and applying paint in a clean condition, free of



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- foreign materials and residue.
- b. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
- c. Do not use thinners for water based paints.
- d. Tinting: Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

### 3.6 APPLICATION

- A. Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated:
  - 1. The term *exposed surfaces* includes areas visible when permanent or built in fixtures, grilles, convactor covers, covers for finned tube radiation, and similar components are in place. Extend coatings in these areas to maintain system integrity and provide desired protection.
  - 2. Use applicators and techniques suited for paint and substrate indicated.
  - 3. Provide finish coats compatible with primers.
  - 4. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
  - 5. Paint exposed surfaces. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces:
    - a. Field painting of exposed surfaces include bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory applied final finish.
    - b. Areas visible when permanent or built in fixtures, grilles, convactor covers, covers for finned tube radiation, and similar components are in place.
    - c. Extend coatings in areas, as required, to maintain system integrity and provide desired protection.
  - 6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
  - 7. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
  - 8. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  - 9. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  - 10. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or surface imperfections. Cut in sharp lines and color breaks.
  - 11. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
  - 12. Provide finish coats compatible with primers used.
  - 13. Sand lightly between each succeeding enamel or varnish coat.
- B. Items not to Receive Paint: Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
- C. Applicators:

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1. Apply paints and coatings by brush, roller, spray, or applicators recommended by manufacturer:
  - a. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
  - b. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool recommended by manufacturer for material and texture required.
  - c. Spray Equipment: Use airless spray equipment with orifice size recommended by manufacturer for material and texture required.
- D. Minimum Coating Thickness:
  1. Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer:
    - a. Measure film thickness on magnetic surfaces by use of Elcometer thickness gauge and on nonmagnetic surfaces by pit gauge or Tooke Gauge.
- E. Application:
  1. Apply first coat to surfaces that have been cleaned, pretreated, or prepared for painting as soon as practicable after preparation and before subsequent surface deterioration:
    - a. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer.
    - b. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished after removing rust and scale and priming or touching up surface sand if acceptable to topcoat manufacturers.
    - c. If undercoats, stains, or conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive dry film thickness equivalent to that of flat surfaces.
    - d. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried and cured to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.
- F. Mechanical and Electrical Work:
  1. Painting of mechanical and electrical work is limited to items exposed in equipment rooms and occupied spaces:
    - a. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
    - b. Prime and paint uninsulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, heat exchangers, tanks, ductwork, conduit, switchgear, and paintable insulation except where items are prefinished.
    - c. Paint interior surfaces of air ducts, and convector and baseboard heating cabinets visible through grilles and louvers with one coat of flat black paint, to visible surfaces. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
    - d. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.
    - e. Color code equipment, piping, conduit, and exposed duct work in accordance with requirements indicated. Color band and identify with flow arrows, names, and numbering.
    - f. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.
    - g. Concealed Members: Wherever steel and metal parts to receive paint are built into



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and concealed by construction, paint as specified for exposed parts so finish painting is complete before members are concealed.

- G. Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
1. Painting is limited to items exposed in equipment rooms and occupied spaces:
    - a. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
    - b. Prime and paint uninsulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, heat exchangers, tanks, ductwork, conduit, switchgear, and paintable insulation except where items are prefinished.
    - c. Paint interior surfaces of air ducts, and convector and baseboard heating cabinets visible through grilles and louvers with one coat of flat black paint, to visible surfaces. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
    - d. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.
    - e. Color code equipment, piping, conduit, and exposed duct work in accordance with requirements indicated. Color band and identify with flow arrows, names, and numbering.
    - f. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.
- H. Electrostatic Spray Painting:
1. Apply coating electrostatically to finished surfaces, free from runs, sags, visible overlaps, holidays, craters, pinholes and other defects detrimental to protective and decorative qualities of coating:
    - a. Thickness of Coatings: 1.5 to 2.0 mils dry film thickness. Measure dry film thickness with magnetic gauge.
    - b. Use application techniques, equipment, materials, and preparation procedures recommended by manufacturer.
- I. Block Fillers: Apply block fillers to concrete masonry block at rate to ensure complete coverage with pores filled.
- J. Prime Coats: Before applying finish coats, apply prime coat, recommended by manufacturer, to material required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or defects due to insufficient sealing.
- K. Finish Coats:
1. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance without bleed through:
    - a. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or surface imperfections is not acceptable.
    - b. Transparent (Clear) Finishes: Use multiple coats to produce glass smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin

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finish for final coats.

- L. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.
- M. Touch Up:
  - 1. Touch up marred, scraped, and blemished areas of surfaces which were factory primed or previously coated:
    - a. Prepare and touch up scratches, abrasions, and blemishes and remove foreign matter before proceeding with succeeding coats.
    - b. Touch up marred, scraped, and blemished areas of factory primed or previously coated surfaces.
    - c. Feather touch up coating overlapping minimum 2 inches onto adjacent unblemished areas producing smooth, uniform surface.
    - d. As soon after erection and installation as possible, touch up fasteners, welded surfaces and surroundings, field connections, and areas on which shop coat has been abraded or damaged with specified primer before corrosion and other damage occurs from exposure.

### 3.7 FIELD QUALITY CONTROL

- A. Dry Film Thickness (DFT) Testing:
  - 1. Tests for dry film thickness may be determined by using a Tooke Scale and microgroover, an electronic scanner, or the Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness:
    - a. Contractor shall touch up and restore painted surfaces damaged by testing.
    - b. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

### 3.8 CLEANING AND PROTECTION

- A. It is of the utmost importance to the AISD that the site remains in a safe, clean, and well maintained condition. At the end of each day, leave the site ready to use by staff and students. Protect staff and students and the learning environment throughout the work.
- B. Cleanup: At the end of each day, remove empty cans, rags, rubbish, and discarded paint materials from site. After completion of painting work, clean glass and paint spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. Provide *Wet Paint* signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work. After related work is complete, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.
- E. At completion of painting activities, touch up and restore damaged or defaced painted surfaces.
- F. Waste Management: Legally dispose of unused paint and paint containers in accordance

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with manufacturer's recommendations and environmental regulations.

## PART 4 SCHEDULES

- A. The following is a schedule of typical painted items and does not specifically include every item that is to receive paint but should establish type and quality of finish for all items normally included in a complete paint job.
  
- B. Exterior Surfaces (Note: Exterior surfaces are divided into two (2) different categories, based upon color and level of graffiti resistance required. System 1 will be used when standard earthtone colors or neutral colors are specified, and System 2 will be used when bright colors (primary reds, yellows, and oranges) are specified and/or when a graffiti resistant coating is required.):
  1. Galvanized Metal:
    - a. Surface Preparation: Acid etch galvanized surfaces that have not weathered at least six (6) months prior to beginning painting operations.
    - b. Primer: One (1) coat Pro-Cryl Pro Industrial Universal Primer (B66W310)
    - c. Finish: Two (2) coats Sher-Cryl HPA High Performance Acrylic (B66W300)
  2. Galvanized Metal - Chloramine environment:
    - a. Surface Preparation: Acid etch galvanized surfaces that have not weathered at least six (6) months prior to beginning painting operations.
    - b. Finish: One coat Macropoxy 646 (B58-600), two (2) coats HS Polyurethane.
  3. Un-galvanized Metal:
    - a. Primer: One (1) coat Pro-Cryl Pro Industrial Universal Primer (B66W310).
    - b. Finish: Two (2) coats Sher-Cryl HPA High Performance Acrylic (B66W300).
  4. Concrete and CMU:
    - a. Primer/Finish: (2) coats Loxon XP Exterior Waterproofing System, 14-18 mils wet, 6.4 – 8.3 mils dry per coat.
  5. All piping in mechanical rooms shall be painted in their entirety, in the following colors:
    - a. Gas lines: Orange
    - b. Domestic cold water: White
    - c. Domestic hot water: Pink
    - d. Heating hot water: Red
    - e. Condenser water: Green
    - f. Chilled water: Blue
  
- C. Interior Surfaces:
  1. Galvanized Metal:
    - a. Primer: One (1) coat Pro-Cryl Pro Industrial Universal Primer (B66W310).
    - b. Finish: Two (2) coats Pro Industrial 0 VOC Acrylic Semi-Gloss.
  2. Shop-Primed Ferrous Metals (Use for metal doors and frames and miscellaneous metal items):
    - a. Shop coat by others.
    - b. One (1) coat over Steel and Aluminum, Pro Industrial Pro-Cryl Universal Primer (B66W610).
    - c. Two (2) coats Pro Industrial Acrylic Semi-Gloss, B66 Series.
  3. Gypsum Wallboard:
    - a. Primer: One (1) coat ProMar 200 Zero VOC Latex Primer (B28W2600).
    - b. Finish: Two (2) coats ProMar 200 Zero VOC Latex Eg-Shel (B20W2651 Series).
    - c. Alternate:
      - 1) Primer: One (1) coat ProMar 200 Zero VOC Latex Primer (B28W2600).
      - 2) Finish: Microbicidal Paint: Paint Shield (EPA# 64695-1).
        - a) Substitutions must meet EPA #64695-1.
  4. Gypsum Wallboard (Epoxy) – Kitchens, bathrooms, laboratories, etc.:

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- a. Primer: One (1) coat ProMar 200 Zero VOC Latex Primer (B28W2600).
  - b. Finish: Two (2) coats Pro Industrial Waterbased Epoxy, Eg-Shel (B73 Series).
  - OR
  - c. Finish - Two (2) coats Pro Industrial Pre-Catalyzed, Eg-Shel (K45 Series):
    - 1) Location: Corridors & Stairwells.
  - 5. Pipe and fittings, including but not limited to copper and brass, at kitchen areas (but excluding aluminum, stainless steel, nickel and chrome plated pipe and fittings):
    - a. Primer: One (1) coat; product recommended for the substrate by the finish coat manufacturer.
    - b. Finish: Two (2) coats bright aluminum paint, S-W BondPlex Aluminum (B71S200).
- D. Paint Types:
- 1. Paint Type (FP-1): Field.
    - a. Number: match Frazee 181
    - b. Color: Match Frazee White Shadow
  - 2. Paint Type (AP-2): Accent.
    - a. Number: SW 6226
    - b. Color: Languid Blue
  - 3. Paint Type (AP-3): Accent.
    - a. Number: SW 6529
    - b. Color: Scanda

**END OF SECTION 09 90 00**

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## **SECTION 10 11 00 MARKERBOARD AND TACKBOARD**

### **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 requirements including but not limited to:
  - 1. Visual display board assemblies.
  - 2. Rail support systems for visual display board assemblies.
  - 3. Modular support systems for visual display board assemblies.
  - 4. Sliding visual display units.
  - 5. Display rails.
  - 6. Accessories necessary for a complete installation.
- B. Related Sections:
  - 1. Section 06 10 00: Rough Carpentry.
  - 2. Section 09 21 16: Gypsum Board Assemblies.
  - 3. Section 09 90 00: Painting and Coating.

#### **1.3 SUBMITTALS**

- A. Product Data:
  - 1. Technical data for each type of product including construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units:
- B. Shop Drawings:
  - 1. Submit plans, elevations, sections, details, and attachment to other work:
    - a. Indicate sizes and layout, method of attachment, accessories, trim, details and finish.
    - b. Show locations of panel joints. Show locations of field assembled joints for factory fabricated units too large to ship in one piece.
    - c. Include sections of typical trim members.
- C. Samples:
  - 1. Submit for each type of visual display unit indicated:
    - a. Visual Display Panel: Not less than 8-1/2 inches by 11 inches (215 mm by 280 mm), with facing, core, and backing indicated for final work. Include one panel for each type, color, and texture required.
    - b. Trim: 6 inch (150 mm) long sections of each trim profile.
    - c. Display Rail: 6 inch (150 mm) long section of each type.
    - d. Modular Support System: 6 inch (152 mm) long sections.
    - e. Accessories: Full size Sample of each type of accessory.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface burning characteristics of tackboards.

#### **1.4 QUALITY ASSURANCE**

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- A. Regulatory Requirements:
  - 1. Surface Burning Characteristics:
    - a. Comply with ASTM E 84; testing 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: 450 or less.
  - 2. Accessibility Requirements:
    - a. Comply with applicable requirements:
      - 1) Americans with Disabilities Act of 1990, as amended:
        - a) ADA Title II Regulations & the 2010 ADA Standards for Accessible Design.
      - 2) CBC 2019 California Building Code (CCR Title 24, Part 2, as adopted and amended by DSA):
        - a) CBC Chapter 11B, Public Buildings, Public Accommodations, Commercial Buildings, and Public Housing.
- B. Installer Qualifications: Entity having minimum 5 years documented experience that employs installers and supervisors who are trained and approved by manufacturer.
- C. Source Limitations: Obtain each type of visual display unit from single source from single manufacturer.
- D. Pre-installation Conference: Conduct conference at site.

## 1.5 WARRANTY

- A. Porcelain Enamel Face Sheets:
  - 1. Written warranty in which Manufacturer agrees to repair or replace porcelain enamel face sheets that fail in materials or workmanship within specified warranty period:
    - a. Failures include, but are not limited to, the following:
      - 1) Surfaces lose original writing and erasing qualities.
      - 2) Surfaces exhibit crazing, cracking, or flaking.
      - 3) Noticeable deterioration of finish.
      - 4) Writing surface delamination.
      - 5) Fabric discoloration, tearing, or delamination.
      - 6) Unit releasing from substrate.
  - 2. Warranty Period: 5 years from date of Substantial Completion.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory fabricated visual display units completely assembled in one piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one piece, provide two or more pieces with joints in locations indicated on approved Shop Drawings.

## PART 2 PRODUCTS

### 2.1 MANUFACTURER

- A. Claridge Products and Equipment Inc
- B. Polyvision Corporation (Nelson Adams)
- C. Best-Rite MooreCo, Inc

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## 2.2 MATERIALS

- A. Porcelain Enamel Face Sheet: PEI-1002, with face sheet two or three coat process.
- B. Glass": tinted ¼" "Starphire" low iron tempered safety glass with polished edges
- C. Natural Cork Sheet: Seamless, single layer, compressed fine grain cork sheet; bulletin board quality; face sanded for natural finish with surface burning characteristics indicated.
- D. Hardboard: ANSI A135.4, tempered.
- E. Particleboard: ANSI A208.1, Grade M-1.
- F. Medium Density Fiberboard: ANSI A208.2, Grade 130.
- G. Fiberboard: ASTM C 208 cellulosic fiber insulating board.
- H. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063.
- I. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by visual display unit manufacturer.
- J. Primer/Sealer: Mildew resistant primer/sealer recommended in writing by visual display unit manufacturer for intended substrate.

## 2.3 VISUAL DISPLAY BOARD ASSEMBLY

- A. Manufacturers:
  - 1. Subject to compliance with requirements, provide products by one of the following:
    - a. AJW Architectural Products.
    - b. Architectural School Products Ltd.
    - c. Best-Rite; MooreCo, Inc.
    - d. Claridge Products and Equipment, Inc.
    - e. Egan Visual Inc.
    - f. EverWhite.
    - g. Ghent Manufacturing, Inc.
    - h. Marsh Industries, Inc.
    - i. Polyvision, Inc (Nelson Adams)
    - j. Platinum Visual Systems.
- B. Visual Display Board Assembly:
  - 1. Field or factory fabricated:
    - a. Assembly: Markerboard, and tackboard.
    - b. Corners: Square.
    - c. Width: Indicated on Drawings.
    - d. Height: Indicated on Drawings.
    - e. Mounting Method: Direct to wall or Modular support system.
- C. Markerboard Panel:
  - 1. Single:
    - a. Glass markerboard panel:
      - 1) Color: Light Blue as supplied by Claridge Products and Equipment, Inc
- D. Tackboard Panel:

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1. Fine grained, homogeneous natural cork
  - a. Color: As selected from manufacturers standard colors
- E. Aluminum Frames:
  1. Fabricated from not less than 0.062 inch (1.57 mm) thick, extruded aluminum; slim size and standard shape of size and shape indicated on Drawings:
    - a. Field Applied Trim: Snap on trim with no visible screws or exposed joints
    - b. Aluminum Finish: Clear anodic finish.
- F. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board as indicated on approved Shop Drawings.
- G. Combination Assemblies: Provide hidden spline between abutting sections of visual display panels.
- H. Marker Tray:
  1. Continuous:
    - a. Box Type: Extruded aluminum with slanted front, grooved tray, and cast aluminum end closures.
- I. Display Rail:
  1. Extruded aluminum display rail with plastic impregnated cork insert, end stops, and continuous paper holder, designed to hold accessories:
    - a. Size: 2 inches (50 mm) high by length indicated on Drawings.
    - b. Map Hooks and Clips: Two map hooks with flexible metal clips for every 48 inches (1200 mm) of display rail or fraction thereof.
    - c. Tackboard Insert Color: Selected by Architect.
    - d. Aluminum Color: Match finish of visual display assembly trim.

## 2.4 VISUAL DISPLAY ASSEMBLIES

- A. Manufacturers:
  1. Subject to compliance with requirements, provide products by one of the following:
    - a. AJW Architectural Products.
    - a. Claridge Products and Equipment, Inc.
    - b. Egan Visual Inc.
    - c. Platinum Visual Systems.
- B. Markerboard Panel Assemblies:
  1. Glass: Tinted ¼" "Starphire" low iron tempered safety glass with polished edges
    - a. Color: Light Blue as supplied by Claridge Products and Equipment, Inc
- C. Tackboard Panel Assemblies:
  1. Tackboard panels fabricated from fine-grained, homogeneous natural cork:
    - a. Cork Thickness: ¼ - inch
    - b. Backing: Hardboard, ¼ - inch thick, laminated to tack surface
    - a. Color: Selected by Architect.
- D. Width: As indicated on Drawings.
- E. Height: As indicated on Drawings.
- F. Joint Accessories: Unless otherwise indicated concealed aluminum or steel spline at butt joints.



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## 2.5 MODULAR SUPPORT SYSTEM FOR VISUAL DISPLAY BOARD ASSEMBLIES

- A. Manufacturers:
  - 1. Subject to compliance with requirements, provide products by one of the following:
    - a. AARCO Products, Inc.
    - b. Architectural School Products Ltd.
    - c. Claridge Products and Equipment, Inc.
    - d. Platinum Visual Systems.
- B. Standards:
  - 1. 72 inch (1829 mm) long extruded aluminum slotted standards designed for supporting visual display boards on panel clips. Space slots at not less than 4 inches (100 mm) o.c.:
    - a. Finish and color: As selected by Architect.
- C. Panel Clips: Extruded aluminum or steel with finish to match standards.

## 2.6 FINISH REQUIREMENTS

- A. Comply with NAAMM *Metal Finishes Manual for Architectural and Metal Products* for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Aluminum Finishes:
  - 1. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.

## PART 3 EXECUTION

### 3.1 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings 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.
- B. Field Measurements:
  - 1. Verify actual dimensions of construction contiguous with visual display units by field measurements before fabrication:
    - a. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

### 3.2 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the work.
- B. Examine roughing in for electrical power systems to verify actual locations of connections before installation of motorized, sliding visual display units.

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- C. Examine walls and partitions for proper preparation and backing for visual display units.
- D. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.
- E. Proceed with installation after correcting unsatisfactory conditions.

### 3.3 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation. Clean substrates of substances, such as dirt, mold, and mildew, that impair the performance of and affect the smooth, finished surfaces of visual display boards.
- B. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display units and wall surfaces:
  - 1. Moisture Content: Maximum of 4 percent when tested with an electronic moisture meter.
  - 2. Prepare substrates indicated to receive glass writing surfaces required by manufacturer's written instructions to achieve a smooth, dry, clean, structurally sound surface that is uniform in color:
    - a. Gypsum Board: Prime gypsum board with primer as recommended in writing by primer/sealer manufacturer and glass writing surface manufacturer.
    - b. Painted Surfaces: Treat areas susceptible to pigment bleeding.
- C. Prime wall surfaces indicated to receive visual display units, direct applied floor to ceiling visual display assemblies and as recommended in writing by primer/sealer manufacturer and visual display unit manufacturer.
- D. Prepare recesses for sliding visual display units as required by type and size of unit.

### 3.4 INSTALLATION

- A. Install visual display surfaces in locations and at mounting heights indicated on Drawings. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- B. Field Assembled Visual Display Board and Tackboard Assemblies:
  - 1. Coordinate field assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit:
    - a. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect.
    - b. Where size of visual display board assemblies or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.
    - c. Field Applied Aluminum Trim: Attach trim over edges of visual display boards and conceal grounds and clips. Attach trim to boards with fasteners at maximum 24 inches (610 mm) o.c.
- C. Factory Fabricated Visual Display Board and Tackboard Assemblies:
  - 1. Attach concealed clips, hangers, and grounds to wall surfaces and to visual display board assemblies with fasteners at not more than 16 inches (400 mm) o.c. Secure tops and bottoms of boards to walls:

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- a. Field Applied Aluminum Trim - Attach trim over edges of visual display boards and conceal grounds and clips. Attach trim to boards with fasteners at maximum 24 inches (610 mm) o.c.
  - b. Mounting Height - Install visual display units at mounting heights indicated on Drawings, or if not indicated, at heights indicated:
    - 1) Mounting Height: 36 inches (914 mm) above finished floor to top of chalktray.
- D. Display Rails:
- 1. Install rails at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners at not more than 16 inches (400 mm) o.c.:
    - a. Mounting Height: 72 inches (1829 mm) above finished floor to top of rail.
- E. Marker Tray:
- 1. Install trays at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners at not more than 16 inches (400 mm) o.c.:
  - 2. Mounting Height: 36 inches above finished floor to top of tray.
- F. Modular Support System:
- 1. Install adjustable standards at mounting heights indicated on Drawings. Install standards at 48 inches (1200 mm) o.c., vertically aligned and plumb, and attached to wall with fasteners at 12 inches (300 mm) o.c.:
    - a. Mounting Height: 12 inches (305 mm) above finished floor to bottom of standard.
  - d. Install single slotted standard at each end of each run of standards and double slotted standards at intermediate locations.
  - e. Provide locking screw at top corner of visual display board at each standard.
  - f. Hang visual display units on modular support system.

### **3.5 CLEANING AND PROTECTION**

- A. Clean visual display units according to manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.
- B. Touch up factory applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display units after installation and cleaning.

**END OF SECTION 10 11 00**

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## **SECTION 10 14 00 GRAPHICS AND SIGNAGE**

### **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 requirements including but not limited to:
  - 1. Room identification signs.
  - 2. Restroom signs.
  - 3. Misc. identification signs.
  - 4. Informational signs (not identification signs).
  - 5. Accessories necessary for a complete installation.
- B. Related Sections:
  - 1. Section 06 10 00: Rough Carpentry.
  - 2. Section 09 21 16: Gypsum Board Assemblies.

#### **1.3 SUBMITTALS**

- A. Product Data: Technical data for each type of signage.
- B. Shop Drawings:
  - 1. Submit fabrication and installation details and attachments to other work:
    - a. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
    - b. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
    - c. Exterior applied signage on face of wall to include mounting brackets and support anchorage to fit condition.
- C. Samples: Submit one sample of each specified sign type, full-sized.

#### **1.4 QUALITY ASSURANCE**

- A. Field Inspections:
  - 1. All new tactile signage must be field inspected after installation per CBC 11B-703.1.1.2.
- B. Accessibility Requirements:
  - 1. Raised characters shall comply with CBC Section 11B-302.2.
    - a. Depth: It shall be 1/32 inch (0.8 mm) minimum above their background, shall be sans serif uppercase, and be duplicated in Braille.
    - b. Height: It shall be 5/8 inch (15.9 mm) minimum and 2 inches (51 mm) maximum based on the height of the uppercase letter "I." See CBC Section 11B-703.2.5.
    - c. Finish and Contrast: Characters and their background shall have a non-glare finish. Character shall contrast with their background with either light characters on a dark background or dark characters on a light background. See CBC Section 11B-703.5.1.
    - d. Proportions: It shall be selected from fonts where the width of the uppercase letter

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"O" is 60% minimum and 110% maximum of the height of the uppercase letter "I."  
Stroke thickness of the uppercase letter "I" shall be 15% maximum of the height of the character. See CBC Sections 11B-703.22.4 and 11B-703.2.8.

- e. Character Spacing: Spacing between individual raised characters shall comply with CBC Section 11B-703.2.7 and 11B-703.2.8.
- f. Format: Text shall be in a horizontal format. See CBC Section 11B-703.2.9.
- g. Braille: It shall be contracted (Grade 2) and shall comply with CBC Sections 11B-703.3 and 11B-703.4. Braille dots shall have a domed or rounded shape and shall comply with CBC Table and Figure 11B-703.3.1.
- h. Mounting Height: Tactile characters on signs shall be located 48 inches minimum to the baseline of the lowest Braille cells and 60 inches maximum to the baseline of the highest line of raised characters above the finish floor or ground surface. See CBC Section and Figure 11B-703.4.4.
- i. Mounting Location: A tactile sign shall be located per CBC Section and Figure 11B-703.4.2 as follows:
  - 1) Alongside a single door at the latch side.
  - 2) On the inactive leaf at double doors with one active leaf.
  - 3) To the right of the right hand door at double doors with two active leaves.
  - 4) On the nearest adjacent wall where there is no wall space at the latch side of a single door or at the right side of double doors with two active leaves.
  - 5) So that a clear floor space of 18 inches x 18 inches minimum, centered on the tactile characters, is provided beyond the arc of any door swing between the closed position and 45 degree open position.
- j. Visual Characters: Shall comply with CBC Section 11B-703.5 and shall be 40 inches minimum above finish floor or ground.
- k. Pictograms: Shall comply with CBC Section 11B-703.6.
- l. Symbols of Accessibility: Shall comply with CBC Section 11B-703.7.
- m. Variable Message Signs: Shall comply with CBC Section 11B-703.8.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Manufacturers:
  - 1. Subject to compliance with requirements, provide products by one of the following:
    - a. Apco Signs
    - b. ASI Modulex, Inc.
    - c. Best Sign Systems, Inc.
    - d. InPro Corporation (IPC).
    - e. Mohawk Sign Systems.
    - f. Nelson-Harkins Industries.
    - g. Seton Identification Products.
    - h. Stamprite Supersine; a division of Stamp Rite Inc.
    - i. Vomar Products, Inc.
- B. Aluminum Castings: ASTM B 26/B 26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated. Refer to drawings for location.
- C. 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. Refer to drawings for location.
- D. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

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- E. Acrylic Sheet: ASTM D 4802, category standard with manufacturer for each sign, Type UVF (UV filtering).
- F. Plastic Laminate Sheet: NEMA LD 3, general purpose HGS grade, 0.048-inch (1.2-mm) nominal thickness.
- G. Vinyl Film: UV resistant vinyl film of nominal thickness indicated, with pressure sensitive, permanent adhesive on back; die cut to form characters or images indicated and suitable for exterior applications.
- H. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.
- I. Accessories:
  - 1. Fasteners and Anchors:
    - a. As necessary for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:
      - 1) Use concealed fasteners and anchors unless indicated to be exposed.
      - 2) Exposed Metal Fastener Components: Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
  - 2. Sign Mounting Fasteners:
    - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.
  - 3. Adhesive: Recommended by sign manufacturer.
  - 4. Two Face Tape: High bond, foam core tape, 0.045 inch (1.14 mm) thick, with adhesive on both sides.
  - 5. Bituminous Paint: Cold applied asphalt emulsion complying with ASTM D 1187.

## 2.2 SIGNAGE

- A. Laminated Plastic Tactile Room, Restroom and Miscellaneous Identification Signs:
  - 1. Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
    - a. Laminated Sheet Sign:
      - 1) Photopolymer face sheet with raised graphics laminated over subsurface graphics to acrylic backing sheet to produce composite sheet:
        - a) Color(s): Selected by Architect from manufacture's full range of standard colors.
    - b. Sign Panel Perimeter:
      - 2) Finish edges smooth:
        - a) Edge Condition: Square.
        - b) Corner Condition in Elevation: Square.
    - c. Mounting at Walls: Stainless steel vandal-proof pin-in-head torx screws Surface mounted to wall with concealed anchors.
    - d. Mounting at Glazing: Clear silicone adhesive.
    - e. Text and Typeface, Panel and Photo Polymer Signs:
      - 3) Accessible raised characters and Braille. Finish raised characters to contrast with background color, and finish Braille to match background color:
        - a) Raised Characters: Refer to Drawings.
        - b) California Contracted Grade 2 Braille: Refer to Drawings.
        - c) Pictograms: Field height of minimum 6 inches; no characters or braille in pictogram field; nonglare, field contrast to pictogram, text descriptors below pictogram field
        - d) Accessibility Symbols: Where used, symbols shall comply with CBC 11B-703.7.

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- B. Solid Plastic Tactile Room, Restroom and Miscellaneous Identification Signs:
  - 1. 1/4-inch thick, Graphic Process Sand Carved with pre-drilled holes for mounting screws:
    - a. Sign Panel Perimeter:
      - 1) Edge Condition: Square cut.
      - 2) Corner Condition in Elevation: 3/8" radius.
    - b. Mounting at Walls: Stainless steel vandal-proof pin-in-head torx screws
    - c. Mounting at Glazing: Clear silicone adhesive
    - d. Text and Typeface:
      - 3) Accessible raised characters and Braille. Finish raised characters to contrast with background color, and finish Braille to match background color:
        - a) Raised Characters: Refer to drawings
        - b) California Contracted Grade 2 Braille: Refer to drawings
        - c) Pictograms: Field height of minimum 6 inches; no characters or braille in pictogram field; nonglare, field contrast to pictogram, text descriptors below pictogram field
        - d) Accessibility Symbols: Where used, symbols shall comply with CBC 11B-703.7.
    - e. Color: As selected by Architect from manufacture's full range of standard colors.
    - f. For exterior uses, fabricate signs from exterior grade materials with UV inhibitor.
- C. Field Applied, Vinyl Character Sign and Graphics:
  - 1. Prespaced characters die cut from 3 mil to 3.5 mil (0.076 mm to 0.089 mm) thick, weather resistant vinyl film with release liner on the back and carrier film on the front for onsite alignment and application:
    - g. Manufacturers:
      - 1) Subject to compliance with requirements, provide products by one of the following:
        - a) Allen Markings.
        - b) APCO Graphics, Inc.
        - c) Mohawk Sign Systems.
        - d) Seton Identification Products.
      - 2) Size: Indicated on Drawings.
      - 3) Substrate: Indicated on Drawings.
      - 4) Graphics: Digital file to be provided by architect

## 2.3 FABRICATION

- A. Provide sign assemblies according to requirements indicated:
  - 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
  - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
  - 3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
  - 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
  - 5. Internally brace signs for stability and for securing fasteners.
  - 6. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.



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## **2.4 FINISH REQUIREMENTS**

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.
- E. Aluminum Finishes:
  - 1. Clear Anodic Finish: AAMA 611, Class I, 0.018 mm or thicker.

## **PART 3 EXECUTION**

### **3.1 FIELD CONDITIONS**

- A. Field Measurements: Verify locations of anchorage devices and electrical service embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

### **3.2 EXAMINATION**

- A. Examine substrates, areas, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of signage work. Verify sign support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- B. Proceed with installation after correcting unsatisfactory conditions.

### **3.3 INSTALLATION**

- A. Install signs using mounting methods indicated and according to manufacturer's written instructions:
  - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
  - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
  - 3. Interior Wall Signs:
    - a. Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches (75 mm) of sign without encountering protruding objects or standing within swing of door:
      - 1) See drawings for the mounting height and location of each sign.
  - 4. Before installation, verify sign surfaces are clean and free of materials or debris that impair installation.
  - 5. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.



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- B. Mounting Height:
  - 1. Tactile characters on signs shall be located 48 inches minimum to the baseline of the lowest Braille cells and 60 inches maximum to the baseline of the highest line of raised characters above the finish floor or ground surface, pursuant to CBC Section and Figure 11B-703.4.1.
- C. Mounting Location:
  - 1. A tactile sign shall be located as follows, pursuant to CBC Section and Figure 11B-703.4.2:
    - a. Alongside a single door at the latch side.
    - b. On the inactive leaf at double doors with one active leaf.
    - c. To the right of the right hand door at double doors with two active leaves.
    - d. On the nearest adjacent wall where there is no wall space at the latch side of a single door or at the right side of double doors with two active leaves.
    - e. So that a clear floor space of 18 inches by 18 inches minimum, centered on the tactile characters, is provided beyond the arc of any door swing between the closed position and 45 degree open position.
- D. Mounting Methods:
  - 1. Exposed Fastener: Install vandal-resistant fastener; set screw head flush with sign face.
  - 2. Concealed Studs:
    - a. Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface:
      - 1) Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
      - 2) Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
  - 3. Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position so that signage is correctly located and aligned.
  - 4. 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 direct mounting methods are impractical. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach signs to plate using method specified above.
- E. Visual Characters shall comply with CBC Section 11B-703.5 and shall be 40 inches minimum above finish floor or ground.
- F. Field Applied, Vinyl Character Signs: Clean and dry substrate. Align sign characters in final position before removing release liner. Remove release liner in stages, and apply and firmly press characters into final position. Press from the middle outward to obtain good bond without blisters or fishmouths. Remove carrier film without disturbing applied vinyl film.
- G. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.
- H. DSA Inspections: Signs and identifications or other information shall be field inspected after installation and approved by Division of the State Architect prior to the issuance of a final certificate of occupancy, or final approval where no certificate of occupancy is issued. The inspection shall include, but not limited to, verification that Braille dots and cells are properly spaced and the size, proportion and type of raised characters are in compliance with CBC, Section 11B-703.1.1.2.

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### **3.4 ADJUSTING AND CLEANING**

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

**END OF SECTION 10 14 00**

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## **SECTION 10 21 13 PHENOLIC CORE TOILET COMPARTMENTS**

### **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. Solid Phenolic (SPC) Core toilet partitions, floor mounted, overhead braced.
  - 2. Related Sections:
    - a. Section 05 50 00: Metal Fabrications.
    - b. Section 06 10 00: Rough Carpentry.
    - c. Section 09 21 16: Gypsum Board Assemblies.
    - d. Section 09 30 00: Tiling.

#### **1.3 SUBMITTALS**

- A. Shop Drawings:
  - 1. Within four (4) weeks of award of contract, submit:
    - a. Complete shop drawings for the Architect's approval, showing all required field measurements, all details and elevations, plans and sections required to indicate all conditions.
    - b. Manufacturer's installation instructions.
    - c. Samples: 2x3 inch samples in each color.
- B. Certification: Provide a certificate of compliance attesting that all materials are in accordance with manufacturer's specifications.
- C. Warranty: Twenty five year against breakage, corrosion and delamination under normal conditions.

#### **1.4 QUALITY ASSURANCE**

- A. Accessibility Requirements:
  - 1. Comply with applicable requirements.
    - a. Americans with Disabilities Act of 1990, as amended.
      - 1) ADA Title II Regulations & the 2010 ADA Standards for Accessible Design.
    - b. CBC 2019 California Building Code (CCR Title 24, Part 2, as adopted and amended by DSA).
      - 1) CBC Chapter 11B, Access to Public Buildings, Public Accommodations, Commercial Buildings and Public Housing.
- B. Manufacturer Qualifications: Minimum 5 years' experience in manufacture of solid plastic toilet compartments with products in satisfactory use under similar service conditions.
- C. Installer Qualifications: Minimum 5 years' experience in work of this Section.
- D. Field Measurements:
  - 1. Field verify dimensions prior to submittals and fabrication.

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## **PART 2 PRODUCTS**

### **2.1 APPROVED MANUFACTURERS**

- A. Any one (1) of the following manufacturers whose product meets or exceeds the specifications for those specified is approved for use on the Project. Other manufacturers must have a minimum of five (5) years' experience manufacturing products meeting or exceeding those specified for design, size, finish, and fabrication and comply with Division 01 requirements for substitutions in order to be considered:
  - 1. Scranton Products, Scranton, PA.
  - 2. Or Architect approved substitute.

### **2.2 MATERIALS**

- A. Basis of Design: Hiny Hiders by Scranton Products.
- B. Doors, Panels and Pilasters:
  - 1. High density polyethylene (HDPE), fabricated from polymer resins compounded under high pressure, forming single thickness panel.
  - 2. Waterproof and nonabsorbent, with self-lubricating surface, resistant to marks by pens, pencils, markers, and other writing instruments.
  - 3. 1 inch thick with edges rounded to 1/4 inch radius.
  - 4. Fire hazard classifications: Not required.
  - 5. Plastic Laminate facing material with edge banding
    - a. Color: Formica Bronzed Steel 8919-58
- C. Headrail: heavy duty aluminum extrusions, anodized with anti-grip configuration, and shall be fastened to the pilaster tops.

### **2.3 HARDWARE**

- A. Hinges:
  - 1. 8 inches long, fabricated from heavy-duty extruded aluminum with bright dip anodized finish, wrap-around flanges, adjustable on 30-degree increments, through bolted to doors and pilasters with stainless steel, Torx head sex bolts.
  - 2. Hinges operate on field-adjustable nylon cams, field adjustable in 30 degree increments.
- B. Door Strike and Keeper:
  - 1. 6 inches long, fabricate from heavy-duty extruded aluminum with bright dip anodized finish, with wrap-around flanges secured to pilasters with stainless steel tamper resistant Torx head sex bolts.
  - 2. Bumper: Extruded black vinyl.
- C. Latch and Housing:
  - 1. Heavy-duty extruded aluminum.
  - 2. Latch housing: Bright dip anodized finish.
  - 3. Slide bolt and button: Black anodized finish.
- D. Coat Hook/Bumper:
  - 1. Combination type, chrome plated Zamak.
  - 2. Equip outswing handicapped doors with second door pull and door stop.
  - 3. Coat Hook Location:
    - a. Accessible Stalls only:
      - 1) Height: 48 inches A.F.F. maximum.

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- E. Door Pulls: Chrome plated Zamak.
- F. Accessible Toilet Compartments:
  - 1. Operable parts shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate operable parts shall be 5 pounds maximum.

## **2.4 COMPONENTS**

- A. Doors and Dividing Panels: 55 inches high, mounted 14 inches above finished floor with aluminum heat-sinc fastened to bottom edges. Provide plastic laminate facing and edge banding.
- B. Pilasters: 82 inches high, fastened to pilaster sleeves with stainless steel tamper resistant Torx head sex bolt. Provide plastic laminate facing and edge banding.
- C. Pilaster Sleeves: 3 inches high, one-piece molded HDPE, secured to pilaster with stainless steel tamper resistant Torx head sex bolt.
- D. Wall Brackets: 54 inches long, extruded PVC fastened to pilaster and panels with stainless steel tamper resistant Torx head sex bolts.
- E. Color: Walnut Riftwood, Matte Finish, 9283-58 as manufactured by Formica. Install grain vertical.
- F. Headrail: Heavy-duty extruded aluminum, anti-grip design, 20ga satin finish, fastened to headrail bracket with stainless steel tamper resistant Torx head sex bolt and at top of pilaster with stainless steel tamper resistant Torx head screws.
- G. Headrail Brackets: 20 gage stainless steel, satin finish, secured to wall with stainless steel tamper resistant Torx head screws.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install in accordance with manufacturer's printed instructions.
- B. Install all toilet partitions where indicated on the drawings, and as indicated on the shop drawings, anchoring all components firmly in place for long life under hard use and in complete accordance with the manufacturer's recommendations.
- C. Provide blocking/anchoring devices to secure to wall. Anchoring devices must be compatible to wall type to ensure adequate strength.

### **3.2 CLEANING AND ADJUSTING**

- A. Clean surfaces free of dirt, oil, grease and other contaminants which detract from appearance of partitions.
- B. Except for compartments for the handicapped, adjust doors to remain at a uniformly open position when unlocked.

### **3.3 REPLACEMENT OF DEFECTIVE MATERIALS**

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- A. Defaced, damaged, scratched or marred materials will not be permitted, will be considered defective, and rejected. Rejected materials shall be replaced with new materials at no additional expense to Owner.

**END OF SECTION 10 21 13.17**

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## **SECTION 10 26 13 CORNER GUARDS**

### **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 requirements including but not limited to:
  - 1. Corner guards.
  - 2. Accessories necessary for a complete installation.

#### **1.3 SUBMITTALS**

- A. Product Data:
  - 1. Technical data for each product, including construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes:
    - a. Fire Ratings: Where applicable, indicate fire ratings of units recessed in fire rated walls and listings for door protection items attached to fire rated doors.
- B. Shop Drawings: Submit for each wall and door protection showing locations and extent of work including plans, elevations, sections, and attachment details. Show handrail design and support spacing required to withstand structural loads.

#### **1.4 QUALITY ASSURANCE**

- A. Regulatory Requirements:
  - 1. Surface Burning Characteristics:
    - a. Comply with ASTM E 84 or UL 723; testing 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: 450 or less.
  - 2. Accessibility Requirements:
    - a. Comply with applicable requirements:
      - 1) U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG) 2010.
      - 2) ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
      - 3) CBC, Section 11B Accessibility.
- B. Source Limitations: Obtain wall and door protection products from single source from single manufacturer.

#### **1.5 WARRANTY**

- A. Written warranty in which the manufacturer agrees to repair or replace components of wall and door protection units that fail in materials or workmanship within specified warranty period:
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.

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- b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.
2. Warranty Period: Five years from date of Substantial Completion.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity:
  1. Maintain room temperature within storage area at not less than 70 degrees F (21 degrees C) during the period plastic materials are stored.
  2. Keep plastic materials out of direct sunlight.
  3. Store plastic wall and door protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 degrees F (21 degrees C):
    - a. Store corner guard covers in a vertical position.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Aluminum: Continuous 6063-T6 aluminum retainer behind entire height of corner guard, minimum 0.060 inch thick.
- B. Plastic Materials: Chemical and stain resistant, high impact resistant plastic with integral color throughout; extruded and sheet material as required, thickness as indicated.
- C. Fasteners: Aluminum, nonmagnetic stainless steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security type fasteners where exposed to view.
- D. Adhesive: Recommended by protection product manufacturer.

### 2.2 WALL PROTECTION

- A. The basis of design is Acrovyn CO-8 as manufactured by Construction Specialties, Inc. Alternate manufacturers listed below shall meet or exceed the basis of design and are subject to compliance with requirements:
  1. Construction Specialties, Inc.
  2. InPro Corporation (IPC).
  3. JL Industries, Inc.
  4. Korogard Wall Protection Systems.
- B. Surface Mounted, Metal Corner Guards:
  1. Fabricated as one piece from formed or extruded metal with formed edges; with 90 degree or 135 degree turn to match wall condition:
    - a. Material: Stainless steel sheet, Type 304:
      - 1) Thickness: Minimum 0.0625 inch (1.6 mm).
      - 2) Finish: Directional satin, No. 4.
    - b. Wing Size: Nominal 3-1/2 inches by 3-1/2 inches (90 mm by 90 mm).
    - c. Corner Radius: 1/8 inch (3 mm)].
    - d. Mounting: Flat head, countersunk screws through factory drilled mounting holes.
    - e. Length: 48" - inches.

### 2.3 FABRICATION



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- A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.
- B. Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- C. Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

## **2.4 FINISHES**

- A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and wall areas for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of the work.
- B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
- C. Proceed with installation after correcting unsatisfactory conditions.

### **3.2 PREPARATION**

- A. Complete finishing operations, including painting, before installing wall and door protection.
- B. Prior to installation, clean substrate to remove dust, debris, and loose particles.

### **3.3 INSTALLATION**

- A. Installation Quality: Install wall protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
- B. Mounting Heights: Install wall and door protection in locations and at mounting heights indicated on Drawings.
- C. Accessories:
  - 1. Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation:
    - a. Provide anchoring devices and suitable locations to withstand imposed loads.
    - b. Where splices occur in horizontal runs of more than 20 feet (6.1 m), splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches (305 mm) apart.
    - c. Adjust end and top caps as required to ensure tight seams.

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### **3.4 CLEANING**

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia based household cleaning agent.

**END OF SECTION 10 26 13**

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## **SECTION 10 28 13 TOILET ACCESSORIES**

### **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 requirements including but not limited to:
  - 1. Public use washroom accessories.
  - 2. Childcare accessories.
  - 3. Underlavatory guards.
  - 4. Custodial accessories.
  - 5. Accessories necessary for a complete installation.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Sanitary Facility Elements:
  - 1. Elements of sanitary facilities shall be mounted at locations in compliance with CBC Sections 11B-602 through 11B-612.
  - 2. Grab bars in toilet facilities and bathing facilities shall comply with CBC Section 11B-609.
  - 3. 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. The space around the grab bars shall be as follows:
    - a. 1 ½ inches between the grab bar and the wall.
    - b. 1 ½ inches minimum between the grab bar and projecting objects below and at the ends.
    - c. 12 inches minimum between the grab bar and projecting objects above.

#### **1.4 SUBMITTALS**

- A. Product Data:
  - 1. Technical Data including construction details, material descriptions, dimensions of individual components and profiles, and finishes:
    - a. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
    - b. Include electrical characteristics.
- B. Samples:
  - 1. Full size, for each exposed product and for each finish specified:
    - a. Approved full size Samples will be returned and may be used in the Work.
- C. Product Schedule: Show types, quantities, sizes, and installation locations by room of each accessory required. Identify locations using room designations indicated.
- D. Maintenance Data: Submit for inclusion in maintenance manuals.

#### **1.5 QUALITY ASSURANCE**

- A. Accessibility Requirements:

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1. Comply with applicable requirements:
  - a. Americans with Disabilities Act of 1990, as amended:
    - 1) ADA Title II Regulations & the 2010 ADA Standards for Accessible Design
  - b. CBC 2019 California Building Code (CCR Title 24, Part 2, as adopted and amended by DSA):
    - 1) CBC Chapter 11B, Access to Public Buildings, Public Accommodations, Commercial Buildings and Public Housing.

B. Source Limitations: Obtain products from single source from single manufacturer.

## 1.6 WARRANTY

- A. Written warranty signed by manufacturer in which manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period:
  1. Failures include, but are not limited to, visible silver spoilage defects.
  2. Warranty Period: 15 years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Basis of Design: Bobrick Washroom Equipment, Inc; All items are to be contractor supplied and installed unless noted otherwise
- B. Manufacturers
  1. Toilet accessories schedule is based on Bobrick Washroom Equipment. Subject to compliance with requirements, provide products by one of the following:
    - a. American Specialties, Inc.
    - b. Bobrick Washroom Equipment, Inc.
    - c. Bradley Corporation.
    - d. Georgia-Pacific Professional
- C. Stainless Steel: ASTM A 666, Type 304, 0.031-inch (0.8-mm) minimum nominal thickness unless otherwise indicated.
- D. Brass: ASTM B 19, flat products; ASTM B 16/B 16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.
- E. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch (0.9-mm) minimum nominal thickness.
- F. Galvanized Steel Sheet: ASTM A 653/A 653M, with G60 (Z180) hot dip zinc coating.
- G. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot dip galvanized after fabrication.
- H. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- I. Mirrors: Annealed float glass nominal 6.0 mm thick, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.
- J. Keys: Provide 2 keys for each accessory to Owner; master key lockable accessories.

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## **2.2 COMPONENTS**

- A. Underlavatory Guard:
  - 1. Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with piping and/or burns from piping; allow service access without removing coverings:
    - a. Product: Truebro LavShield Protective Lavatory Enclosure.
    - b. Material and Finish: Antimicrobial, molded plastic, white.
    - c. Provide at all lavatories.

## **2.3 FABRICATION**

- A. Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

## **PART 3 EXECUTION**

### **3.1 COORDINATION**

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

### **3.2 INSTALLATION**

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to ASTM F 446.

### **3.3 ADJUSTING AND CLEANING**

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items. Remove temporary labels and protective coatings. Clean and polish exposed surfaces according to manufacturer's written recommendations.

## **PART 4 SCHEDULE**

### **4.1 ACCESSORY SCHEDULE**

- A. Combination Toilet Paper Dispenser, Seat Cover Dispenser, Sanitary Napkin Disposal: Double roll, recessed, stainless steel unit with pivot hinge, tumbler lock.
  - 1. Product: B-35745 manufactured by Bobrick. (recessed)
  - 2. Product: B-3579 manufactured by Bobrick. (surface mounted)

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- B. Combination Towel Dispenser/Waste Receptacle: Recessed flush with wall (so as to allow required clearance of 1-1/2 inches at grab bars), stainless steel; seamless wall flanges, continuous piano hinges, tumbler locks on upper and lower doors.
  - 1. Waste receptacle liner: Reusable, heavy-duty vinyl.
  - 2. Waste receptacle capacity: 12 gallons.
  - 3. Product: B-3944 manufactured by Bobrick.
- C. Automated Soap Dispenser: Foam soap dispenser, deck-mounted on lavatory, with container concealed below deck; chrome-plated brass with bright polished finish; chrome-plated deck escutcheon.
  - 1. Product: Sloan 3346095
- D. Mirrors: Stainless steel framed, 1/4 inch thick annealed float glass; ASTM C1036.
  - 1. Size: 18x36 UON.
  - 2. Frame: 0.05 inch angle shapes, with mitered and welded and ground corners, and tamperproof hanging system; satin finish.
  - 3. Backing: Full-mirror sized, minimum 0.03 inch galvanized steel sheet and non-absorptive filler material.
  - 4. Shelf: Stainless steel; gage and finish to match mirror frame, turned down edges, welded to frame; 5 inches deep, full width of mirror.
  - 5. Product: B-165 1836 manufactured by Bobrick.
- E. Grab Bars: Stainless steel, nonslip grasping surface finish.
  - 1. Standard Duty Grab Bars:
    - a. Push/Pull Point Load: 250 pound-force, minimum.
    - b. Dimensions: 1-1/4 inch outside diameter, minimum 0.05 inch wall thickness, exposed flange mounting, 1-1/2 inch clearance between wall and inside of grab bar.
    - c. Length and Configuration: As indicated on drawings.
    - d. 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.
    - e. Products:
      - i. B-6806.
- F. Diaper Changing Stations:
  - 1. Type: Horizontal station to accommodate infants and toddlers.
  - 2. Construction and Features:
    - a. FDA approved injection molded polypropylene with steel on steel hinge system. Fabricate to withstand static loads over 400 pounds.
    - b. Child protection straps with snap lock fasteners.
    - c. Built in diaper bag hooks.
    - d. Built in sanitary liner dispensers; 3 ply, biodegradable.
    - e. Premium gas spring mechanism.
    - f. Molded usage and safety instructions in six languages and Braille.
    - g. ADA compatible.
    - h. Antifungal to comply with ASTM standards.
  - 3. Color: Selected by Architect from the full list of standard colors.
  - 4. Dimensions: 35 inches long by 22 inches high by 4 inches deep (875 mm by 550 mm by 100 mm).
  - 5. Approved Product/Manufacturer: Koala Bear Kare Baby Changing Stations, Model KB 200, manufactured by Koala Bear Kare.

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G. Custodial Room Accessories

1. Combination Utility Shelf/Mop and Broom Holder: 0.05 inch thick stainless steel, Type 304, with 1/2 inch returned edges, 0.06 inch steel wall brackets.
  - a. Drying rod: Stainless steel, 1/4 inch diameter.
  - b. Hooks: 2, 0.06 inch stainless steel rag hooks at shelf front.
  - c. Mop/broom holders: 3 spring-loaded rubber cam holders at shelf front.
  - d. Length: Manufacturer's standard length for number of holders/hooks.

**END OF SECTION 10 28 13**

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## **SECTION 10 44 00 FIRE EXTINGUISHER AND CABINETS**

### **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. Fire Extinguisher Cabinets.
  - 2. Fire Extinguishers
- B. Related Sections:
  - 1. Section 06 10 00: Rough Carpentry.

#### **1.3 SUBMITTALS**

- A. Product Data:
  - 1. Manufacturer's specifications and technical data to indicate specification compliance.
  - 2. Manufacturer's installation instructions.

### **PART 2 PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Specifications are based on the products of named manufacturers. Other listed manufacturers who produce products equivalent to those specified are approved for use on the Project. Other manufacturers must have a minimum of five (5) years' experience manufacturing equivalent to those specified and comply with Division 1 requirements regarding substitutions to be considered:
  - 1. Larsen's Manufacturing Co.
  - 2. The Williams Bros. Corporation of America.
  - 3. J. L. Industries, Inc.
  - 4. Potter-Roemer.

#### **2.2 MATERIALS**

- A. Fire Extinguishers and Cabinets must comply with CBC Sections 11B-307, 11B-308, 11B-309, and 11B-403.
- B. Fire Extinguisher Cabinets (FEC):
  - 1. Size: 24 inches x 9-1/2 inches x 6 inches inside tub dimension.
  - 2. Type: Semi-recessed with 2-1/2 inch return trim rolled edge; ADA compliant.
  - 3. Tub Construction: 22 gauge min. steel with standard baked acrylic enamel interior finish.
  - 4. Door and Frame: 18 gauge min. 304 stainless steel door and frame with vertical decal lettering "FIRE EXTINGUISHER" in red color, unless directed otherwise by Architect.
  - 5. Glazing: clear acrylic "Duo" vertical glazing panel
  - 6. Hardware: Continuous concealed piano hinge constructed of material which matches door and trim material. Satin finish pull handle with cam cylinder lock with safety pull designed to release upon firm pull on handle (Larsen's "Larsen-Loc"™, J.L. Industries



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"Saf-T-Lok"™; or equivalent).

7. Bracket: Hook type; Larsen's #1007, or equal.
8. Finish of Exterior: #4 Stainless steel.
9. Fire rating: as occurs, provide fire rated cabinet, for one or two hour rated conditions as indicated or required by specific location. Cabinet shall be tested and approved by Warnock Hersey to ASTM E-814, and shall bear the Warnock Hersey label.

C. Fire Extinguishers (F.E):

1. Models/Types:
  - a. Multipurpose dry chemical with 10 lbs. capacity and UL 4A-80B: C rating conforming to MP10 Series.
2. Mounting: Provide eye brackets for direct wall mounting to hook and for mounting in Fire Extinguisher cabinets. Refer to drawings for location and quantity.
3. Provide initial inspection tag for each extinguisher.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install fire extinguishers and cabinets in openings in accordance with manufacturer's printed instructions.
- B. Install fire extinguishers and cabinets where indicated on the drawings, or if not indicated, in locations required by governing code and as directed by Owner.

**END OF SECTION 10 44 00**

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## **SECTION 11 52 13 AUDIOVISUAL EQUIPMENT - PROJECTION SCREENS**

### **PART 1 GENERAL**

#### **1.1 SCOPE OF WORK**

- A. The work under this section includes all final design, all labor, material, equipment, supplies, Alignment, testing, transportation and accessories required to furnish and install a complete projection screen installation as indicated on the drawings and as specified herein.
- B. It is the intent of the Drawings and Specifications, for the Contractor to design, provide and install a complete, fully operational, and tested system.
- C. All miscellaneous system components including, but not limited to, plenum cables, speakers, signal converters, interface panels and components, termination equipment, patch panels, backboards, converters, matrix switchers, digital video extenders, controllers, digital signal processors, amplifiers, pre-amps, custom faceplates, mounting hardware, fasteners, racks, cabinets, and any other related items shall be furnished and installed complete under this section, such that the system shall perform all functions listed herein in compliance with all of the specified requirements.

#### **1.2 SUMMARY**

- A. This Section includes permanently affixed audiovisual projection screens as required to complete the work of this project.

#### **1.3 RELATED DOCUMENTS**

- A. Section 270500 and all divisions of the specification and general provisions of the Construction Documents.
- B. Architectural, mechanical, electrical, and all technology drawings.
- C. Refer to Structural Seismic Requirement design documents Specifications, if available, for Non-Structural Components for all structural bracing and support of telecommunications equipment.
- D. Related Sections include the following:
  - 1. Division 26 Sections for electrical wiring, connections, and installation of remote control switches and interfaces for electrically operated projection screens.
  - 2. Division 27 41 16 Integrated Audio Video Systems and Equipment

#### **1.4 QUALITY ASSURANCE**

- A. The work of this section shall be performed by a company, which specializes in the installation of projection screens as required for this Project with a minimum of 5 years of documented successful experience and shall be performed by skilled workers thoroughly experienced in the necessary crafts.
  - 1. Work shall be performed in compliance with Owner's insurance underwriters' requirements.

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- B. Manufacturer shall specialize in manufacturing the type of specified projection screen described in this section, with a minimum of 10 years of documented successful experience and have the facilities capable of meeting all requirements of Contract Documents as a single-source responsibility and warranty for each type of projection screen.
  - 1. Obtain all projection screens from one source from a single manufacturer.
  - 2. Obtain each screen as a complete unit, including necessary mounting hardware, low voltage control interfaces, switches, and accessories.
- C. Manufacturer's identification tags or marks are not acceptable on surfaces that will remain exposed to view after installation.
  - 1. Evidence of "patching" after removal of tags or marks is not acceptable.
- D. Coordination of Work: Coordinate layout and installation of projection screens with other construction supported by, or penetrated through, ceilings, including light fixtures, HVAC equipment, fire suppression system, and partitions.

## 1.5 SUBMITTALS

- A. Submit the following according to Conditions of the Construction Contract and Division 1 Specification Sections:
- B. Product Data: Shall be clearly marked to indicate all technical information that specifies full compliance with requirements of this section and Contract Documents, including manufacturer's published installation recommendations for each type and size of projection screen required.
- C. Shop Drawings: Shall clearly indicate but not be limited to:
  - 1. Location of screen centerline relative to ends of screen case.
  - 2. Location of wiring connections.
  - 3. Connections to suspension systems for screens mounted in recessed surfaces (e.g., ceilings).
  - 4. Anchorage details.
  - 5. Details of juncture of exposed surfaces with adjacent finishes.
  - 6. Frame details.
  - 7. Accessories.
  - 8. Wiring diagrams for electrically operated units.

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- D. Maintenance Data: Shall clearly describe cleaning methods, cleaning solutions recommended and stain removal methods.
- E. Hazardous Materials Notification: In the event no product or material is available that does not contain asbestos, PCB or other hazardous materials as determined by the Owner, a "Material Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.
- F. Asbestos and PCB Certification: After completion of installation, but prior to Substantial Completion, Contractor shall certify in writing that products and materials installed, and processes used, do not contain asbestos or polychlorinated biphenyls (PCB),

## **1.6 DELIVERY, HANDLING, STORAGE**

- A. Do not deliver projection screens until building is enclosed.
- B. Protect screen surfaces from damage during installation from abrasion, dust and other conditions.

## **1.7 WARRANTY**

- A. Comply with General Conditions and Product Requirements, agreeing to repair or replace specified materials or Work that has failed within the warranty period.

## **1.8 UNAUTHORIZED MATERIALS**

- A. Materials and products required for work of this section shall not contain asbestos, polychlorinated biphenyls (PCB), or other hazardous materials identified by the Owner.

## **1.9 ACCEPTABLE MANUFACTURER**

- A. General: For the purpose of establishing the minimum functional, aesthetic and quality standards required for work of this section, products of the following manufacturers are specified:
- B. Note: Modify this section per project
  - 1. Da-Lite Screen Company, Inc., Warsaw, IN (219) 267-8101
- C. Substitutions: Comply with General Conditions using Substitution Request Form.

## **PART 2 PRODUCTS**

### **2.1 MANUALLY OPERATED PROJECTION SCREENS (AS PER PROJECT REQUIREMENTS)**

- A. General: Manufacturer's standard spring-roller-operated units, consisting of case, screen, mounting accessories, and other components necessary for a complete installation.
- B. Recessed Ceiling, Metal-Encased, Manually Operated Screens: Units designed and fabricated for surface mounting on wall or ceiling, fabricated from formed-steel sheet or from aluminum extrusions; with flat back design and vinyl covering or baked-enamel finish.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Da-Lite Screen Company; Advantage Manual with CSR (Ceiling Recessed).

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- C. Surface mounted from ceiling, mounted at a diagonal, Metal-Encased, Manually Operated Screens: Units designed and fabricated for surface mounting on wall or ceiling, fabricated from formed-steel sheet or from aluminum extrusions; with flat back design and vinyl covering or baked-enamel finish.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Da-Lite Screen Company; Model C with CSR.

## **2.2 FRONT-PROJECTION SCREEN MATERIAL**

- A. Matte-White Viewing Surface: Peak gain not less than 1.0, with half Angle 60 degrees from the axis of the screen surface.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Da-Lite Screen Company; Matte White.
- B. Seamless Construction: Provide screens, in sizes indicated, without seams.
- C. Edge Treatment: Without black masking borders.
- D. Size of Viewing Surface:
  - 1. 60"H x 96"W per Campus Standards

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install projection screens at locations indicated to comply with the manufacturers written instructions.
- B. Install front projection screens with screen cases in position and in relationship to adjoining construction as indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when the screen is in the lowered position.
- C. Test electrically operated units to verify that the screen, controls limit switches, closure, and other operating components are in optimum functioning condition and that the screens meet all manufacturer's published performance specifications.

### **3.2 CLEANING AND PROTECTION**

- A. Protect projection screens after installation from damage during ongoing construction activity. If damage occurs despite such protection, remove and replace damaged components or entire unit as required to provide units in their original, undamaged condition.

**END OF SECTION 11 52 13**

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## **SECTION 12 21 13 WINDOW BLINDS**

### **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 requirements including but not limited to:
  - 1. Horizontal Shade Devices.
  - 2. Accessories necessary for a complete installation.

#### **1.3 SUBMITTALS**

- A. Product Data: Technical data for each type of product.
- B. Shop Drawings - Submit fabrication and installation details:
- C. Samples - For each exposed product and for each color and texture specified, 12 inches (300 mm) long:
  - 1. Slat: Not less than 12 inches (300 mm) long.
  - 2. Tapes: Full width, not less than 6 inches (150 mm) long.
  - 3. Horizontal Louver Blind: Full size unit, not less than 16 inches (400 mm) wide by 24 inches (600 mm) long.
  - 4. Valance: Full-size unit, not less than 12 inches (300 mm) wide.
- D. Product Test Reports: For horizontal louver blinds with polymer slats that have been tested for compliance with NFPA 701, for tests performed by.
- E. Maintenance Data: Submit data to include in maintenance manuals.

#### **1.4 QUALITY ASSURANCE**

- A. Source Limitations: Obtain horizontal louver blinds from single source from single manufacturer.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver horizontal louver blinds in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

### **PART 2 PRODUCTS**

#### **2.1 MATERIALS**

- A. Manufacturers:
  - 1. Manufacturers are subject to compliance with requirements; provide products by one of the following:
    - a. MechoShade Systems <http://www.mechoshade.com>.
    - b. Skyco <http://www.skycoshade.com>.
    - c. Draper <http://draperinc.com/WindowShades/index.asp>.

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d. Approved equal.

- B. Product:
1. Roller shades to comply with WCMA A 100.1.
  2. Flame Resistance Rating: Pass NFPA 701.
  3. Darkening Shade Material:
    - a. 10% Open Material.
    - b. ThermoVeil, Open Basket Weave, 2119 Silver Birch
  4. Black-out Shade Material:
    - a. Room darkening (PVCFree) Shadecloth with opaque acrylic backing MechoShade System, Inc. 008 inches thick (19mm) blackout material and weighing 94 lbs. per square yard comprising of 53 percent fiberglass, 45 percent acrylic, 2 percent poly finish.
    - b. Distinctive Blackout, Silver Birch 0819
  5. Rollers and Housing:
    - c. Electro-galvanized or epoxy primed steel or extruded aluminum tube and wall thickness of appropriate diameter and gauge to not sag over required spans.
    - d. No plastic hardware allowed.
    - e. Assembly must be easy to remove for replacement of material.
  6. Brackets:
    - a. Galvanized or zinc plated steel.
  7. Operations:
    - a. Manual: Stainless steel chain pulls.

## **PART 3 EXECUTION**

### **3.1 FIELD CONDITIONS**

- A. Environmental Limitations: Do not install horizontal louver blinds until construction and wet-work and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where horizontal louver blinds are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

### **3.2 EXTRA MATERIALS**

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents:
1. Operable rolling shade device: Full size units equal to 5 percent of quantity installed for each size, color, texture, pattern, and gloss indicated, but no fewer than two units.

### **3.3 INSTALLATION**

- A. Install shades at locations scheduled, noted on the drawings, or as directed by the Architect in accordance with manufacturer's installation procedures, except as otherwise specified herein.
- B. Install intermediate support and extension brackets as needed to prevent deflection in

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headrail.

- C. Install shades with adequate clearance to permit smooth operation with minimum clearance of 1/4 inch from each side of window opening on inside mount, unless other clearance is indicated or suggested by manufacturer.

### **3.4 CLEANING AND DEMONSTRATION**

- A. Clean in accordance with manufacturer's instructions.
- B. Provide final protection and maintain conditions that ensures shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged horizontal louver blinds that cannot be repaired in a manner approved by Architect before time of Substantial Completion.

### **3.5 DEMONSTRATION**

- A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems.

**END OF SECTION 12 21 13**



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## **SECTION 12 36 61 SIMULATED STONE COUNTERTOPS**

### **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 solid polymer countertops with sinks:
  - 1. Solid-surface-material countertops
- B. Related Sections:
  - 1. Section 06 10 00: Rough Carpentry.
  - 2. Section 06 20 00: Finish Carpentry and Millwork.
  - 3. Division 22: Plumbing.

#### **1.3 SUBMITTALS**

- A. Product Data:
  - 1. Indicate product description, fabrication information, and compliance with specified performance requirements.
- B. Shop Drawings: For countertops. Show materials, finishes, edge, and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
- C. Samples:
  - 1. Submit minimum 2 inches by 2 inches samples. Indicate full range of color and pattern variation for Architect's selection.
  - 2. Submit 12 inch long by 4 inches wide sample in color and pattern selected and approved by Architect. Approved sample will be retained as standards for work.
- D. Maintenance Data: Submit manufacturer's care and maintenance data, including repair and cleaning instructions. Include in project close-out documents.

#### **1.4 QUALITY ASSURANCE**

- A. Allowable Tolerances:
  - 1. Variation in Component Size: Plus or minus 1/8 inch.
  - 2. Fabricator/Installer Qualifications: Approved by manufacturer of solid polymer.
- B. Mock-Up(s):
  - 1. Prior to final approval of shop drawings, erect one full-size mock-up of each component at project site for Architect review.
  - 2. Rework or remake mock-up until accepted; remove rejected units from project site. Acceptable mock-ups shall remain as part of finished work.
- C. Provide all solid polymer fabrications from a single manufacturer.

#### **1.5 WARRANTY**

- A. Warrant the work specified herein for 10 years against becoming unserviceable or causing

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an objectionable appearance resulting from both defective, or nonconforming materials or workmanship.

- B. Defects shall include, but not be limited to the following:
  - 1. Shrinking, warping, cracking, chipping, splitting, or deteriorating excessively.
  - 2. Becoming loose from substrate.
  - 3. Inadequate color depth

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components to project site when areas are ready for installation. Store components indoors prior to installation.
- B. Handle materials to prevent damage to finished surfaces. Provide protective coverings to prevent physical damage or staining following installation for duration of project.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Specifications are based on **Corian Quartz manufactured by E. I. du Pont de Nemours and Company** (formerly known as DuPont™ Zodiaq® Quartz Surface) or Architect approved equal. Listed manufacturers whose products meet or exceed those specified are approved for use on this Project. Other manufacturers must have a minimum of five (5) years' experience manufacturing equivalent products to those specified and comply with Division 1 requirements regarding substitutions to be considered:
  - 1. Silestone Quartz

### 2.2 SOLID SURFACE COUNTERTOPS

- A. Material, General - Solid Quartz Surface: Quartz surface materials generally consist of natural quartz particles, reacted monomers and resins, pigments and various performance-enhancing additives manufactured as slabs of various specific calipers.
- B. Performance Characteristics:
  - 1. Compression Strength: 27,300 psi, minimum (Dry) 24,400 psi minimum (Wet), ASTM C170/C170M
  - 2. Flexural Strength: >5,300 psi, minimum, ASTM D790.
  - 3. Colourfastness: No effect, NEMA LD3.3.3.
  - 4. Abrasion Resistance: 139, ASTM C501.
  - 5. Flame Spread / Smoke Development: Class I/Class A, ASTM E-84.
- C. Countertops with Sinks:
  - 1. Material: 1/2 inch thick countertop of solid polymer material.
  - 2. Edge Details: As indicated on the drawings.
  - 3. Sink: Drop-in sink shown on drawings.
  - 4. Fabrication: Provide counter complete with backsplash of size shown on the drawings.
  - 5. Color/Finish: Color Cocoa Prima

### 2.3 ACCESSORY PRODUCTS

- A. Joint Adhesive: Manufacturer's standard two-part adhesive kit to create inconspicuous, nonporous joints, with chemical bond.
- B. Sealant: Manufacturer's standard mildew-resistant, FDA/UL recognized silicone sealant in

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color-matching or clear formulations.

- C. Sink/bowl Hardware: Manufacturer's approved bowl clips, inserts and fasteners.

## **2.4 FABRICATION**

- A. Fabricate components in shop to greatest extent practical to sizes and shapes indicated, in accordance with approved shop drawings and solid polymer manufacturer requirements.
- B. Form joints between components using manufacturer's standard joint adhesive, joints inconspicuous in appearance and without voids. Attach 2 inch wide reinforcing strip of solid polymer material under each joint.
- C. Rout and finish component edges to a smooth, uniform finish. Rout all cutouts, then sand all edges smooth. Repair or reject defective or inaccurate work.
- D. Finish all surfaces uniformly, matte: Gloss rating of 5-20.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install components plumb and level, in accordance with approved shop drawings and product installation details.
- B. Form field joints using manufacturer's recommended adhesive, with joints inconspicuous in finished work. Keep components and hands clean when making joints.

### **3.2 CLEANING AND PROTECTION**

- A. Keep components and hands clean during installation. Remove adhesives, sealants, and other stains. Components shall be clean on Date of Substantial Completion.
- B. Protect surfaces from damage until Date of Substantial Completion. Repair or replace damaged work that cannot be repaired to architect's satisfaction and invoice for the cost of repairs; before repairs are made, cost estimates are subject to architect's approval.

### **3.3 MAINTENANCE INFORMATION**

- A. Provide Care and Maintenance information to Owner upon completion of Project.
- B. Review maintenance procedures and warranty details with the Owner upon completion of project.

**END OF SECTION 12 36 61**

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## **SECTION 21 05 17 SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Sleeves.
  - 2. Sleeve-seal systems.
  - 3. Grout.

#### **1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.

#### **1.3 SLEEVES**

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

#### **1.4 SLEEVE-SEAL SYSTEMS**

- 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. Advance Products & Systems, Inc.
  - 2. CALPICO, Inc.
  - 3. Metraflex Company (The).
- C. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
  - 1. Sealing Elements: NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: Stainless steel.
  - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

#### **1.5 GROUT**

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

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- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## 1.6 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. 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.
  - 2. Using grout, 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. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Comply with requirements for fire stopping specified in Section for "Penetration Fire stopping."

## 1.7 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.

## 1.8 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 wall sleeves.
    - b. Piping NPS 6 and Larger: Cast-iron wall sleeves.
  - 2. Exterior Concrete Walls below Grade:
    - a. Piping Smaller than NPS 6 Cast-iron wall sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

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- b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal systemized-steel-pipe sleeves with sleeve-seal system.
    - 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 wall sleeves with sleeve-seal system
    - 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 wall sleeves with sleeve-seal system.
    - 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: PVC-pipe sleeves.
  - b. Piping NPS 6 and Larger: PVC-pipe sleeves.
- 5. Interior Partitions:
  - a. Piping Smaller Than NPS 6: PVC-pipe sleeves.
  - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

**END OF SECTION 21 05 17**

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## **SECTION 21 05 18 ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Escutcheons.
  - 2. Floor plates.

#### **1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.

### **PART 2 PRODUCTS**

#### **2.1 ESCUTCHEONS**

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

#### **2.2 FLOOR PLATES**

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

### **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 piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
    - c. Insulated Piping: One-piece, stamped-steel type.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
    - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
    - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
    - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.

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- h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
  - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
  - j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.
  - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.
- 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: One-piece, floor-plate type.

### **3.2 FIELD QUALITY CONTROL**

- A. Replace broken and damaged escutcheons and floor plates using new materials.

**END OF SECTION 21 05 18**



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## **SECTION 21 05 53 IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT**

### **PART 1 GENERAL**

#### **1.1 SUBMITTALS**

- A. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Product Data: Provide manufacturers catalog literature for each product required.
- C. Samples: Submit two labels 2 by 6 inch in size.

### **PART 2 PRODUCTS**

#### **2.1 IDENTIFICATION APPLICATIONS**

- A. Automatic Controls: Tags.
- B. Control Panels: Nameplates.
- C. Instrumentation: Tags.
- D. Major Control Components: Nameplates.
- E. Piping: Tags.
- F. Pumps: Nameplates.
- G. Relays: Tags.
- H. Small-sized Equipment: Tags.
- I. Thermostats: Nameplates.
- J. Valves: Nameplates and ceiling tacks where above lay-in ceilings.

#### **2.2 NAMEPLATES**

- A. Description: Laminated three-layer plastic with engraved letters.
  - 1. Letter Color: White.
  - 2. Letter Height: 1/4 inch.
  - 3. Background Color: Black.
  - 4. Thickness: 1/8 inch.
  - 5. Plastic: Comply with ASTM D709.

#### **2.3 TAGS**

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

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- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

## **2.4 STENCILS**

- A. Stencils: With clean cut symbols and letters of following size:
1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
  2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
  3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
  4. Equipment: 2-1/2 inch high letters.
- B. Paint for Stencils: As specified in Section 09 91 23, semi-gloss enamel, colors complying with ASME A13.1.

## **2.5 PIPE MARKERS**

- A. Color: Comply with ASME A13.1.
- B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
- E. Color code as follows:
1. Fire Quenching Fluids: Red with white letters.

## **2.6 CEILING TACKS**

- A. Description: Steel with 3/4 inch diameter color coded head.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Apply stencil painting in accordance with Section 09 91 23.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

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**END OF SECTION 21 05 53**

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## **SECTION 21 13 13 WET PIPE SPRINKLER AND STANDPIPE SYSTEM**

### **PART 1 GENERAL**

#### **1.1 GENERAL AND SPECIAL CONDITIONS:**

- A. General and special conditions apply to the work in this section
- B. The contractor shall furnish all equipment, materials, tools, labor, engineering, drawings, etc. necessary for a complete fire protection system, with said system being made ready for the operations in accordance with the requirements of the Authority Having Jurisdiction. The purpose of the permit drawings and specifications is to convey to the contractor the scope of work required, all of which the Contractor is responsible to furnish, install, adjust, and make operable. The omission of the Owner of any necessary system component as required by the Authority Having Jurisdiction, in the specifications shall not relieve the Contractor of the responsibility for providing such necessity, without additional cost to the owner. The Contractor shall visit the site before submitting his bid and shall examine all existing physical conditions that may be material to the performance of his work. No extra payment will be allowed to the contractor as a result of extra work made necessary by his failure to do so. Any case of error, omission, discrepancy or lack of clarity shall be promptly identified to the owner, Architect, Engineer for clarification prior to the bid due date.
- C. The Contractor shall provide all devices and equipment required by these specifications. Under no circumstances will the Contractor delete any equipment or devices without the written directive of the Owner.
- D. This Section specifies materials, methods, and equipment to be used for automatic sprinkler system or a combine standpipe system and related fire protection piping to 5 ft outside building.
- E. Each wet pipe zone shall begin with:
  - 1. Zone control valve with tamper switch.
  - 2. Check Valve (Combined standpipes).
  - 3. Flow switch.
  - 4. Inspectors test and drain valve.
  - 5. Pressure gauges.
- F. This Section specifies design criteria for fire protection system. Zone and main piping layouts of fire protection system have been established, as it relates to architecture, structure and mechanical/electrical systems. Fire Protection Contractor, based on these layouts, shall produce installation drawings which are also referred to as shop drawings in this Specification.

#### **1.2 SYSTEM ABBREVIATIONS AND DEFINITIONS**

- A. AHJ – Authority Having Jurisdiction
- B. ANSI – American National Standard Institute
- C. Approved – Unless otherwise stated, materials, equipment or submittal approved by the Engineer.
- D. Architect – HGA Architect
- E. ASTM – American Society for Testing and Materials

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- F. AWS – American Welding Society
- G. AWWA – American Water Works Association
- H. Concealed – Where used in connection with installation of piping or conduit and accessories, shall mean, "Hidden from sight" as in shafts, furred spaces, in soffits or above suspended ceilings.
- I. Contractor – The Company awarded the prime contract for this work and any of its subcontractors, vendors, suppliers, or fabricators.
- J. Engineer – P2S Engineering
- K. Exposed - Where used in connection with installation of piping or conduit and accessories, shall mean, "visible" or "not concealed".
- L. FDC – Fire Department Connection
- M. FM – FM Global.
- N. FM Approved – Materials or equipment approved by Factory Mutual and included on the most recent edition of the FM Approval Guide.
- O. Furnish – Supply materials.
- P. GPM – Gallons per minute.
- Q. Install – Install materials, mount, and connection equipment assemblies.
- R. NFPA – National Fire Protection Association
- S. PIV – Post indicating valve.
- T. Provide – Furnish, install and connect.
- U. PSI – pounds per square inch.
- V. Remove – Remove material and equipment and restore surface.
- W. UL – Underwriters Laboratories, Inc.
- X. UL Listed – Materials or equipment by Underwriters Laboratories and included in the most recent edition of the UL Fire Protection equipment Directory.

### 1.3 SCOPE OF WORK:

- A. Provide complete fire protection system as outlined in the project specifications, including all labor, materials, permit, shop drawings and hydraulic calculations needed to furnish and install a complete functional automatic sprinkler system in accordance with NFPA 13, and all of the following:
  - 1. Wet pipe automatic sprinkler system throughout the building, complete with supervised control valves, inspectors test and main drains assemblies, vane type water flow switch, and pressure gauges.
  - 2. The sprinkler on each floor shall have a control valve, check valve, flow and tamper switch, and inspector test and drain assembly, located within fire riser closet.

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3. Class II, standpipes in accordance with CBC Section 905, provided at each side of the stage
4. Any required core drilling of floors and walls, and provide FM approved non-combustible fire stopping materials at all fire protection piping penetrations of fire resistance rated construction. Piping penetrations shall be adequately fire stopped to maintain the fire resistance rating required.
5. Earthquake bracing and flexible coupling.
6. Furnish, install and adjust all waterflow and valve supervisory switches.
7. Coordinate all work with other trades. During bidding, Contractor shall review his work with other trade to identify any obstructions from beams, ducts, diffusers, lights, structures, etc. Provide cost allowance for piping adjustment, additional piping and sprinklers as required. All changes shall be reflected on shop drawings.
8. Coordinate and interface of alarm initiating and supervisory devices with the fire alarm system.
9. Coordinate size of sewer connection with the drain riser with plumbing contractor to ensure adequate drainage of the drain riser during testing.
10. Fire department connections.
11. Shop drawings.
12. Two (2) sets of operating instructions and valve diagrams.
13. As-built drawings. The Contractor shall provide as-built drawings in Revit and PDF format in addition to required full size reproducible drawings.
14. Contractor shall provide hydraulic calculation if there is any deviation or propose deviation from the approved set as a result of site condition and coordination.
15. On-site project supervision.
16. Required signs in English at all control valves, main drains, auxiliary drains and inspectors test connections, etc., including hydraulic placards, in accordance with NFPA 13 and NFPA 14 requirements.
17. Cabinet containing the required number and type of spare sprinklers and corresponding wrenches, to be located in riser room.
18. All required system testing in accordance with NFPA 13, 14, 22, 24, and 25.
19. Warranty on all materials and labor.
20. All permits, taxes and fees, including AHJ inspection and testing fees necessary to complete the specified work.

#### **1.4 RELATED WORK:**

- A. Materials and methods specified in other sections, included but not limited to:
  1. Cutting and patching.
  2. Fire extinguishers, cabinets, and accessories.
  3. Painting of finished surfaces at pipe penetrations by other than Contractor.
  4. Grading.
- B. Materials furnished and installed in this section but wired by others:
  1. Valve supervisory devices shall be furnished and installed the Contractor but wired by the alarm contractor.
  2. Water flow switches shall be furnished and installed by the Contractor but wired by the alarm contractor.

#### **1.5 DESIGN CRITERIA**

- A. Flow Test: See drawings.
- B. This flow test data will be used as basis for Contract Documents. Sprinkler Contractor, prior to preparation of installation design calculations, shall validate this flow data.

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- C. Send current hydrant flow test data to Engineer.
- D. Hydraulically calculated system shall be designed to a minimum of 10% below available water flow curve.
- E. Systems that are hydraulically calculated must include 1.2 factor for design area.
- F. Sprinkler System:
  - 1. Office areas and general building spaces shall be hydraulically designed to provide minimum density of 0.10 gpm per sq ft over most hydraulically remote 1500 sq ft. Maximum spacing shall not exceed 225 sq ft per head.
  - 2. Other mechanical equipment areas and storage areas shall be hydraulically designed to provide minimum density of 0.15 gpm per sq ft for most remote 1500 sq ft. Maximum spacing shall not exceed 130 sq ft per head.
  - 3. Stage areas shall be hydraulically designed to provide minimum density of 0.20 gpm per sq ft over most hydraulically remote 1500 sq ft. Maximum spacing shall not exceed 100 sq ft per head.
- G. Hose Streams:
  - 1. Add 250 gpm hose stream to sprinkler zone hydraulic calculations.
- H. Standpipes and Hose Stations
  - 1. A Class II hose standpipe system shall be provided in accordance with the requirements of CBC Section 905 within every required stairwell.
  - 2. Pipe sizing for standpipes shall be 2 1/2 inches minimum.
  - 3. Standpipes shall be provided with 2½-inch fire hose valves.
  - 4. Pressure-reducing fire hose valves shall be provided where operating pressure exceeds 100 psi at 250 gpm.
  - 5. Fire hose valves shall be located within the stair enclosure at the main floor or intermediate landing.
- I. Fire Protection System Layout and Shop Drawings:
  - 1. Contractor shall review Design Drawings and Specifications, and shall produce Shop Drawings, calculations, and product data sheets.
  - 2. Conceal sprinkler piping above ceilings where possible.
  - 3. Contractor shall consult with Architect during development of piping layout to avoid conflicts with general appearance. Pipe routing is a critical issue due to attributes of this building.
  - 4. Submit shop drawings, calculations and product data sheets for coordination review to: Architect, and other Authorities Having Jurisdiction over this Project prior to installation (see submittals).
  - 5. Contractor shall be held to have examined "Reflected Ceiling" drawings as well as Mechanical, Electrical, Piping, Information Technology, Structural and Architectural building plans prior to system layout.
  - 6. Contractor shall coordinate routing of piping with other trades and Architect.
  - 7. Contractor shall participate in coordination process and shall not install piping prior to coordination with other trades.

## 1.6 QUALITY ASSURANCE:

- A. Codes and Standards:
  - 1. NFPA 13, Installation of Sprinkler Systems
  - 2. NFPA 14, Installation of Standpipe and Hose Systems
  - 3. NFPA 72, National Fire Alarm Code
  - 4. Underwriters Laboratories (UL) Fire Protection Equipment Directory

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5. California Building Code – Latest Version
  6. California Fire Code – Latest Version
  7. California Plumbing Code – Latest Version
  8. Title 19 of California Code of Regulations
- B. Contractor Installation Program:
1. Licensed persons employed by Sprinkler Contractor shall perform planning, calculations, layout, and installation. Certified sprinkler designer, National Institute for Certification of Engineering Technologies, (NICET) Level IV or licensed Professional Engineer for planning and calculations, and journeyman sprinkler fitters for installation foreman and supervisory personnel.
  2. Journeyman automatic fire sprinkler fitter(s) shall supervise field installation.
  3. Contractor shall be licensed in the State of California for Installation of Fire Protection Systems.
  4. Contractor shall submit pre-qualification evidence of at least 3 projects of comparable size successfully completed with their Bid.
  5. Distortion or misrepresentation of qualification evidence may result in Contract cessation.
- C. Electrical Coordination:
1. All relays, wire, conduit, pushbuttons, pilot lights, and other devices required for power side or the control of electrical equipment shall be furnished by Division 26 and Division 28 contractors, except as specifically noted elsewhere in this specification.
  2. Should any change in electrical equipment size, horsepower rating or means of control be made to any motor or other electrical equipment after contracts are awarded, sprinkler contractor is to immediately notify Division 26 and Division 28 contractors of this change and pay any costs due to this change.
  3. Division 26 contractors shall provide all power wiring and sprinkler contractor shall provide all control wiring and its conduit. Control wiring shall conform to Division 26 and 28 requirements for control wiring.
  4. Sprinkler contractor shall provide exterior waterflow alarm and coordinate installation with Division 26 and Division 28 contractors.
  5. Furnish wiring diagrams to Division 26 and Division 28 contractors for all equipment and devices furnished by the sprinkler contractor which have been indicated to be wired by the Division 26 and Division 28 contractors.

## 1.7 APPROVALS

- A. P2S Engineering has prepared permit drawings, which have been approved by DSA. The Contractor shall use these drawings to prepare shop drawings to be used in system installation. The contractor shall submit the shop drawings to the Engineer for approval prior in system installation.

## 1.8 SUBMITTALS:

- A. Contractor shall submit complete system packages. Partial submittals will be rejected.
- B. Shop Drawings
1. Contractor shall review Design Drawings and Specifications and shall produce Shop Drawings, calculations and product data sheets.
  2. Conceal sprinkler piping above ceilings where possible.
  3. Contractor shall consult with Architect during development of piping layout to avoid conflicts with general appearance. Pipe routing is a critical issue due to attributes of this building.



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4. Submit three sets of complete shop drawings, and three sets of manufacturer's data to Architect, Engineer, DSA, and other Authorities Having Jurisdiction for all necessary reviews prior to fabrication and installation of materials. Three sets of hydraulic calculations shall be provided if contractor propose any deviation to the approved set.
  5. Hydraulic calculations shall include a water supply graph and hydraulic cover sheet. The cover sheet shall include the name and location of the calculated area, ceiling height, occupancy, design criteria, sprinkler spacing, system type, sprinkler make, model, size, K-factor and temperature rating, flow requirements, C-factor used, water supply data and source of information.
  6. Contractor shall be held to have examined "Reflected Ceiling" drawings as well as Mechanical, Electrical, Piping, Information Technology, Structural and Architectural building plans prior to system layout.
  7. Contractor shall coordinate routing of piping with other trades and Architect.
  8. Contractor shall participate in coordination process and shall not install piping prior to coordination with other trades.
  9. Prepare shop drawings with a minimum scale of 1/8 inch = 1 foot-0 inch for plans, and 1/4 inch = 1 foot-0 inch for details. Show all piping, sprinklers, hangers, type of pipe, tube connections, outlets, type of roof construction, and occupancy of each area, including ceiling and roof heights as required by NFPA 13. When welding is planned, shop drawings shall indicate the sections to be shop welded and the type of welded fittings to be used. All drawings shall be prepared using Revit.
  10. Design shall be based on these specifications and the appropriate NFPA standards.
  11. Shop drawings shall include details of earthquake sway bracing, including the appropriate calculations.
  12. Shop drawings shall include details of underground thrust blocking/restraints.
- C. Changes
1. Make no changes in installation from layout as shown on the bridging drawings unless change is specifically approved by the Engineer and AHJ. This does not include minor revisions for the purpose of coordination.
  2. Any pipe fabricated and/or installed before all approvals are obtained at the Contractor's own expense and responsibility. Any changes made to the approved drawings other than as stated above are at the Contractor's own expense and responsibility.
- D. Manufacturer's Data
1. Provide data from manufacturer on the following devices, including installation, maintenance, and testing procedures, dimensions, wiring diagrams, etc. Where any devices that are provided or furnished involve work by someone other than the Contractor, submit additional data copies directly to the Contractor. At a minimum, the following data sheets shall be provided:
    - a. Sprinklers and escutcheons.
    - b. Pipe, fittings and hangers.
    - c. Control valves.
    - d. Tamper switches.
    - e. Flow switches.
    - f. Exterior Weatherproof Waterflow Alarm.
    - g. Sprinkler Heads.
    - h. Sprinkler Head Cabinet.
    - i. Hanger Assemblies
    - j. Pressure Gauges.
    - k. Drawings.
    - l. Seismic Restraint Detailing.
    - m. Fire Department Connection (FDC)
    - n. Fire Department Valves (FDV).
    - o. Check valves.
    - p. Waterflow devices.

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- q. Valve supervisory devices.
    - r. Fire hose valve.
    - s. Bell.
    - t. Fire stopping materials (including installation detail).
  - 2. Include items listed in product section and additional items required to provide complete installation.
  - 3. Indicate by red marking or arrow, items to be used where more than 1 item appears on manufacturer's catalog sheet.
  - 4. Submit shop drawings and equipment submittals to Engineer and Owner's Insurance representative prior to installation or fabrication of system components.
  - 5. Review of submittals does not relieve Contractor from coordinating installation of work with other trades, or from compliance with Codes and Standards.
- E. As-Built Drawings
- 1. Maintain at the site an up-to-date marked set of as-built drawings, which shall be corrected and delivered to the Owner upon completion of work.
  - 2. Upon completion, furnish the Owner with 3 sets of reproducible sepia prints, and one set in electronic Revit and PDF format of each reviewed shop drawing, revised to show "as-built" conditions.
- F. Samples
- 1. Provide one sample of each type of sprinkler and escutcheon.
- G. Final Inspection and Test
- 1. The Contractor shall make arrangements with the Owner, Owner's commissioning agent, Architect, Engineer for final inspection and witnessing of the final acceptance tests. The Owner, Architect, and the Engineer will witness the final inspection.
  - 2. Perform all tests and inspections required by the referenced codes and standards, the AHJ, and the Owner.
  - 3. When the Engineer visits the job site for final inspection and tests after being advised by the Contractor that the work is complete and ready for test, if the work has not been completed or the final acceptance tests are unsatisfactory, the Contractor shall be responsible for the Engineer's extra time and expenses for reinspection and witnessing the retesting of the work. Such extra fees shall be deducted from payments by the Owner to the Contractor.
  - 4. Upon completion of final inspections and tests, as required by appropriate NFPA Standards, submit copies of Standard Contractor's Material and Test Certificate.
- H. Operating Instruction
- 1. At the completion of the work, provide a small scale plan of building indicating the locations of all control valves, low point drains, and inspector's test valves. The plans shall be neatly drawn and color-coded to indicate the portion of the building protected by each system, framed under glass and permanently mounted on the wall at the pump room.
  - 2. Furnish one copy of the latest version of NFPA 25, California Edition and bound set of printed operating and maintenance instructions to the Owner, and adequately instruct the Owner's maintenance personnel in proper operation and test procedures of all fire protection components provided, furnished, or installed.

## 1.9 SPARE PARTS

- A. Provide and install one spare sprinkler cabinet, complete with 12 sprinklers of all types and temperature ratings used throughout the installation. The cabinet shall be equipped with sprinklers and special sprinkler wrenches required for each type of sprinkler installed.

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- B. Confer with the Owner's representative for exact location of cabinet.

#### **1.10 GUARANTEE**

- A. The Contractor shall guarantee all materials and workmanship for a period of one year beginning with the date of final acceptance by the Owner. The Contractor shall be responsible during the design, installation, testing and guarantee periods for any damage caused by his (or his subcontractors') work, materials, or equipment.

#### **1.11 PRODUCT DELIVERY**

- A. Delivery of Materials: Delivery of all materials and equipment to the job site shall be scheduled to assure compliance with the predetermined construction schedules.
- B. Storage of Materials, Equipment and Fixtures: Contractor shall be responsible for storage of materials on job site, including furnishing of any storage facilities or structures required.
- C. Handling Materials and Equipment: Contractor shall be responsible for on-site handling of materials and equipment.

#### **1.12 QUALITY ASSURANCE**

- A. Testing Agency: All materials shall be UL listed or FM approved for their intended use.
- B. Regulatory Agencies: State and local building codes and ordinances, and fire department requirements shall apply.
- C. The Contractor shall be fully experienced and licensed in all aspects of the fire protections systems herein specified.
- D. Similar materials shall be from a single manufacturer.

#### **1.13 JOB CONDITIONS**

- A. Damage: Protect all unfinished work to prevent damage and furnish protection of all surrounding areas where necessary.
- B. Leak Damage: The Contractor shall be responsible during the installation and testing periods of the sprinkler system for any damage to the work of others, to the building or its contents caused by leaks in any equipment, by unplugged or disconnected pipes or fittings, or by overflow, and shall pay for the necessary replacements or repairs to work of others damaged by such leakage.

#### **1.14 EMERGENCY SERVICE**

- A. The Contractor shall provide emergency repair service for the sprinkler system within four hours of a request for such service by the Owner during the warranty period. This service shall be available on a 24-hour per day, seven-day per week basis.

#### **1.15 TRAINING**

- A. The Contractor shall conduct two training sessions of four hours each to familiarize the facility personnel with the features, operation and maintenance of the sprinkler systems. Training sessions shall be scheduled by the Owner at a mutually agreeable time to the Contractor and the Owner.

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## 1.16 PERMITS AND FEES

- A. Pay for all permits, fees and charges required for this work.

## PART 2 PRODUCTS

### 2.1 GENERAL

- A. All components shall be used in accordance with the manufacturer's recommendations and its UL listing and/or FM approval.
- B. The naming of manufacturers in the specifications shall not be construed as eliminating the materials, products or services of other manufacturers and suppliers providing approved equivalent items.
- C. The substitutions of materials or products other than those named in the specifications are subject to proper approval of the Owner granted in writing.

### 2.2 MATERIALS

- A. Materials and Equipment
  - 1. Materials and equipment in system shall be new and current products of manufacturer regularly engaged in production of such materials and equipment.
  - 2. Where 2 or more pieces of equipment are required to perform interrelated functions, they shall be products of 1 manufacturer.
  - 3. Clean and cap pipe after fabrication and prior to placing pipe in building.
  - 4. Mark pipe with tags that can be removed during installation, so no permanent markings remain on unpainted pipe located in exposed areas.
  - 5. Couplings shall be tees with capped outlets.
- B. Approval Guides:
  - 1. Unless otherwise shown, products shall be UL Listed in the latest publication of the UL Fire Protection Equipment Directory or Approved in the latest Factory Mutual Approval Guide for service intended.

### 2.3 PIPE

- A. Above Ground:
  - 1. Standpipe Piping
    - a. Carbon steel pipe, Schedule 10, ASTM A795, ASTM A53 or A135, roll grooved for mechanical fittings.
    - b. Carbon steel pipe, Schedule 40, ASTM A795, ASTM A53 or A135, cut-grooved for mechanical fittings.
    - c. Provide metal pipe's exposed threads with corrosion inhibitive paint.
    - d. Pipe shall be new, Schedule 10, 6-inch minimum, rated for 300 psi, conforming to ASTM specifications, and have the manufacturer's name and brand along with the applicable ASTM standard marked on each length of pipe.
      - 1) Pipe used shall be black steel and must comply with the specifications of the American Society for Testing and Materials, ASTM A 53 welded and seamless steel pipe.
  - 2. Feed Mains and Branch Piping
    - a. Carbon steel pipe, Schedule 10, ASTM A795, ASTM A53 or A135, roll-grooved for mechanical fittings.
    - b. Carbon steel pipe, Schedule 40, ASTM A795, ASTM A53 or A135, cut-grooved for mechanical fittings.

WET PIPE SPRINKLER AND STANDPIPE SYSTEM

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- c. In areas such as tight ceiling spaces or where exact center-of-tile placement is critical, only FlexHead sprinkler pipe is permitted. Models 2024, 2036, 2048, 2060, 2072 as manufactured by FlexHead Industries, Acton Massachusetts. Each FlexHead ceiling sprinkler system shall include multi-port ceiling mounting bracket and a 1-piece tested FlexHead sprinkler drop including adjustable flange and hardware. No other flexible sprinkler pipe is allowed for this project unless it is both UL Listed and FM Global Approved. Alternates to FlexHead flexible sprinkler pipe must also be acceptable to Owner.
- d. Provide metal pipe's exposed threads with corrosion inhibitive paint.
- e. Pipe shall be new, rated for 175 psi working pressure, conforming to ASTM specifications, and have the manufacturer's name and brand along with the applicable ASTM standard marked on each length of pipe.
  - 1) Pipe used shall be black steel and must comply with the specifications of the American Society for Testing and Materials, ASTM A53 for welded and seamless steel pipe.
  - 2) Schedule 40 piping is required for sizes 2 inches and less. Pipe ends shall be threaded or roll grooved in accordance with NFPA 13.
  - 3) Schedule 10 piping shall be provided for sizes 2½ inches and larger. Pipe ends shall be welded or roll grooved in accordance with NFPA 13.
  - 4) Hot-dipped galvanized pipe shall be used when exposed to the outside.
  - 5) Hot-dipped galvanized pipe shall be used for drain pipe.

## 2.4 FITTINGS AND JOINTS

- A. Above Ground:
  - 1. Cast iron threaded, Class 125, 175 psi WOG pressure rating, ANSI B16.4.
  - 2. Cast iron flanged, Class 125, 175 psi WOG pressure rating, ANSI B16.1.
  - 3. Grooved:
    - a. Ductile iron or malleable iron, grooved for mechanical coupling, 175 psi WOG pressure rating, malleable iron conforming to ASTM A536 for ductile iron and ASTM A47 for malleable iron.
    - b. Fitting, gasket and coupling shall be furnished by same manufacturer.
    - c. Acceptable manufacturers: Victaulic, Gruvlok or Viking Corp.
    - d. Grooved fittings and couplings shall be produced by the same manufacturer.
    - e. Grooved couplings shall be dimensionally compatible with pipe.
  - 4. Screwed fittings shall be cast iron, 175 pound class, black, and in accordance with ANSI B 16.4 or malleable iron, 175 pound class, black and in accordance with ANSI B 16.3. Bushings shall not be used.
  - 5. Fitting, gasket and coupling shall be furnished by same manufacturer.
  - 6. Galvanized, cast iron, threaded fittings, 175 psi WOG pressure rating, ANSI B16.4.
  - 7. Fittings shall be hot-dipped galvanized when installed on galvanized piping.
  - 8. Weld-o-lets welded to piping in fabrication shops are permitted. No welding allowed at project site.
  - 9. Weld fittings shall be steel, standard weights, black, and in accordance with ASME B 16.9, ASME B 16.25, ASME B 16.5, ASME B 16.11 and ASTM A 234.
  - 10. Pipe-o-lets or similar clamp on or saddle type fittings are not allowed as fittings.
  - 11. Saddle type devices that strap or clamp onto piping are not allowed.

## 2.5 FIRE HOSE VALVES

- A. ~~Hose threads shall match those used by AHJ. Each hose valve shall be provided with an approved pressure-reducing device designed to limit nozzle pressure to 100 psi at 2½-inch valves, where necessary.~~

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## 2.6 VALVES:

- A. ~~Gate Valve:~~
  - 1. ~~Acceptable manufacturers: Kennedy, Milwaukee Valve Co., Mueller, Nibco, Stockham, Victaulic.~~
  - 2. ~~Outside screw and yoke (OS&Y), gate valve, bronze body and trim or cast iron body bronze mounted and rated for 175 psi, non-shock cold water working pressure, Nibco F-607-OTS or equal.~~
- B. ~~Check Valve:~~
  - 1. ~~Acceptable manufactures: Tyco Fire Products, Reliable, Viking Corp.~~
  - 2. ~~Iron body, bronze seat, stainless steel clapper with a replaceable rubber seal and 175 psi nonshock cold water working pressure. Viking Model G-1 or equal.~~
- C. ~~Ball Valve:~~
  - 1. ~~Acceptable manufacturers: Nibco, Milwaukee Valve Co., Mueller, Victaulic.~~
- D. ~~Butterfly Valve:~~
  - 1. ~~Acceptable manufacturers: Victaulic, Kennedy, Milwaukee Valve Co.~~
  - 2. ~~Victaulic Series 705 Firelock or equal for valve sizes 2-1/2" to 8".~~
  - 3. ~~Milwaukee Valve Co., Series BB or equal.~~
  - 4. ~~Kennedy Valve Co., Fig. 01G.~~
- E. ~~Test and Drain Valves:~~
  - 1. ~~Acceptable manufacturers: AGF, Victaulic or equal.~~
  - 2. ~~AGF Test and Drain Victaulic Style 720 TestMaster II or equal may be installed.~~
- F. ~~Drain Valves:~~
  - 1. ~~Acceptable manufacturers: Kennedy, Nibco or equal.~~
  - 2. ~~Thread-in bonnet bronze globe valves, rated to 175 psi non-shock cold water working pressure.~~
  - 3. ~~Low point drain valves shall have, 3/4" brass nipple with 3/4" male hose threads and cap.~~

## 2.7 FIRE DEPARTMENT CONNECTION

- A. ~~Fire department connection shall be pilaster mounted with four (4) 2½-inch inlets connected to a 6-inch pipe.~~
- B. ~~Plate shall describe area of service.~~
- C. ~~Finish for plate and connector shall be chrome.~~
- D. ~~Exposed caps and fittings shall be chrome.~~

## 2.8 TAMPER SWITCH

- A. ~~Acceptable manufacturers: Potter, System Sensor or equal.~~
- B. ~~Outside screw and yoke (OS&Y) supervisory switch, NEMA 4 enclosure, provided with 2 sets of contacts rated at 2.5 Amps at 30 VDC and 15 Amps at 125/250 VAC. Equal to Potter OSYSU-2. Provide with cover tamper kit. For areas identified as hazardous locations, provide "EX" Model.~~

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- C. ~~Control valve supervisory switch, NEMA 4 enclosure, provided with 2 sets of contacts rated at 2.5 Amps at 30 VDC and 15 Amps at 125/250 VAC. Equal to Potter PCVS-2. Provide with optional cover tamper kit. For areas identified as hazardous locations, provide "EX" Model.~~
- D. ~~Tamper switch shall be capable of transmitting signal during first 2 revolutions of handwheel or during 1/5 of travel distance of valve control apparatus from its normal position.~~
- E. ~~Unit shall be compatible with Fire Alarm System.~~

## 2.9 FLOW SWITCH

- A. ~~Acceptable manufacturers: Potter, System Sensor, or equal.~~
- B. ~~Vane type waterflow switch for use in wet sprinkler systems, 450 psi service pressure rating, 40 gpm minimal flow rate to activate alarm, 2 sets of SPDT (Form C) contacts rated at 2 Amps at 30 VDC and 15 Amps at 125/250 VAC. Provide with optional cover tamper kit. Equal to Potter VSR-F.~~
- C. ~~Unit shall be compatible with Fire Alarm System. Potter model VSR-F or equal.~~

## 2.10 FLEXIBLE HOSE

- A. Flexible hose sprinkler system shall be rated for the following performance criteria:
  - 1. FM Approved for its intended use pursuant to FM 1637 Approval Standard for Sprinkler Hose with Threaded End Fittings.
  - 2. UL Listed for its intended use pursuant to UL 2443 Standard for flexible Sprinkler Hose with Fittings for Fire Protection Service.
  - 3. Seismically qualified for use pursuant to ICC-ES AC-156 Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems.
- B. Materials: Flexible hose commercial sprinkler connections.
  - 1. Composition shall be 100% Type 304 Stainless Steel.
  - 2. Straight Hose Assembly Lengths:
- C. ¾ inch outlet
- D. Maximum pressure rating: 175 psi.
- E. Fully welded non-mechanical fittings, braided, leak-tested with minimum 1 inch true-bore internal corrugated hose diameter.
  - 1. Elbow hose assembly lengths (for use in confined spaces).
- F. 1/2 inch outlet
- G. Maximum pressure rating: 175 psi
- H. Fully welded non-mechanical fittings, braided, leak-tested with minimum 1 inch true-bore internal corrugated hose diameter.
  - 1. Ceiling Bracket
- I. Type G90 Galvanized Steel
- J. Type: Direct attachment type, having integrated snap-on clips ends positively attached to the ceiling using tamper resistant screws.



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- K. Flexible hose attachment: Removable hub type with set screw.

## 2.11 SPRINKLER HEAD

- A. Fire sprinklers installed on wet system shall be of one manufacturer throughout the building. No mixing of sprinkler brands shall be permitted.
- B. Manufacturers: Unless otherwise noted below, shall be manufactured by Viking Corp., Tyco Fire Products or Reliable.
- C. Automatic, having temperature rating suitable for location.
- D. Light Hazard and Ordinary Hazard occupancies shall be Quick Response type sprinkler heads.
- E. Architect will review deviations from the specified styles for approval prior to installation.
- F. Provide the following type of sprinkler head.
1. Unfinished areas such as areas with no ceiling, mechanical spaces, storage, etc.
    - a. Quick response, brass Upright, 1/2" orifice, ordinary temperature class (175°F),
    - b. Viking Model Microfast or equal.
    - c. Extended coverage, brass finish, Upright or Pendent, large orifice, ordinary temperature class (175°F), Viking ECOH-ELO or equal designed and installed per its listing.
  2. In areas with ceilings.
    - a. Concealed Pendent, 1/2" orifice, intermediate temperature class (175°F) solder link, Viking Mirage QR Concealed Pendent, Model B-2 adjustable sprinkler, with 165°F temperature rated cover plate, flush with ceiling or equal. Cover plate color shall match ceiling color and shall be factory-painted (i.e. by manufacturer).
  3. In areas where ceiling conditions do not permit installation of pendent head or finished area where sidewall head provides better coverage of hazard.
    - a. Polished Chrome Sidewall, 1/2" orifice, ordinary temperature class (175°F), 2-piece adjustable chrome escutcheon, Viking Model M, HSW horizontal or VSW vertical sidewall with Viking E-1 escutcheon or equal.
    - b. Extended Coverage Sidewall, ordinary temperature class (175°F), Tyco Fire Products, Model TY-FRB or equal designed and installed per its listing.
  4. In unfinished areas where conditions do not permit installation of upright or pendent head.
    - a. Brass Sidewall, 1/2" orifice, ordinary temperature class (175°F), Viking Model M, HSW horizontal or VSW vertical sidewall or equal.
  5. In parking garage areas.
    - a. Quick response, brass Upright or pendent, 1/2" orifice, intermediate temperature class (200°F),
    - b. Viking Model Microfast or equal.
    - c. Below duct sprinkler shall be pendent type. Sprinkler guard shall be provided where sprinkler heads are located below 7 feet from finished floor.
- G. Submit samples for examination and approvals.
- H. Temperature ratings of sprinkler heads shall vary if installed close to heat sources, under skylights or in special hazard areas.
- I. Sprinkler Cabinets:



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1. Complete with required number of spare sprinkler heads of each type and temperature
2. rating and special wrenches per NFPA 13
3. Provide multiple cabinets to meet this requirement.
4. Coordinate cabinet locations with Owner's representative.

## 2.12 ~~BALL DRIP~~

- A. ~~Acceptable manufacturer: Potter-Roemer, Reliable, Tyco Fire Products or equal.~~
- B. ~~Provide bronze ball drip for Fire Department connection inside of building and pipe to nearest floor drain, or discharge to exterior.~~
- C. ~~Exterior discharge must be coordinated with Architect and Owner.~~

## 2.13 HANGERS

- A. Provide hangers to support piping: in perfect alignment without sagging or interference, to permit free expansion and contraction, and meet requirements of NFPA 13.
- B. Riser clamps shall not protrude more than 2" beyond edge of hole. Provide Anvil Fig. 261 or equal.
- C. Concrete expansion anchors are to be Hilti, Rawl, or Phillips concrete fasteners.

## 2.14 EARTHQUAKE BRACING

- A. Sprinkler and standpipe system shall be protected from earthquake influence in accordance with requirements of NFPA 13 and as outlined in Section 20 0549 - Seismic Anchorage and Restraints.
- B. Provide flexible couplings, bracing, and other components required, compatible with piping material and jointing system used.
- C. Seismic detailing shall be included on Fire Protection System layout shop drawings.

## 2.15 ~~PRESSURE GAUGES~~

- A. ~~Acceptable manufacturers: Potter-Roemer, Viking or equal.~~
- B. ~~Pressure gauges shall be 3-1/2", corrosion resistant moving parts, polycarbonate window, and provided with connection not smaller than 1/4" NPT.~~
- C. ~~Include shutoff valve with provisions for draining on each pressure gauge.~~

## 2.16 DIELECTRIC FITTINGS

- A. Acceptable manufacturers: Epco Sales, Inc., Lochinvar, Watts Regulator Co., Wilkins or equal.
- B. Insulating nipple, metal casing, inert thermoplastic lining, Clearflow dielectric fitting by Perfection Corporation.

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- C. Dielectric unions 2" and smaller; dielectric flanges 2" and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets and pressure rating of not less than 175 psig at 180°F.

## 2.17 SLEEVES FOR WALL/FLOOR PENETRATIONS

- A. Sleeves through walls and floors shall be of a type that can be made watertight and fire stopped.
  - 1. Sleeve sizes shall be as required by NFPA 13 and 14 for Earthquake Protection.

## 2.18 SIGNS

- A. Provide standard metal signs in English in accordance with NFPA 13.
- B. Provide hydraulic calculation information signs at risers in accordance with NFPA 13.

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Product Delivery
  - 1. Delivery of Materials: Delivery of all materials and equipment to the job site shall be scheduled to assure compliance with the predetermined construction schedules.
  - 2. Storage of Materials, Equipment and Fixtures: Contractor shall be responsible for storage of materials on job site, including furnishing of any storage facilities or structures required.
  - 3. Handling Materials and Equipment: Contractor shall be responsible for on-site handling of materials and equipment.
- B. Clean-up
  - 1. Maintain the premises free from accumulation of waste materials or rubbish caused by this work.
  - 2. At the completion of the work, removed all surplus materials, tools, etc., and leave the premises clean.
- C. Leak Protection
  - 1. Damage: Protect all unfinished work to prevent damage and furnish protection of all surrounding areas where necessary.
  - 2. Leak Damage: The Contractor shall be responsible during the installation and testing periods of the fire protection system for any damage to the work of others, to the building or its contents caused by leaks in any equipment, by unplugged or disconnected pipes or fittings, or by overflow, and shall pay for the necessary replacements or repairs to work of others damaged by such leakage.
- D. Safety
  - 1. All work shall be performed in compliance with the Occupational Safety and Health Act of 1970 and the Construction Safety Act Standards.
  - 2. Contractor shall attend all job safety meetings.

### 3.2 FABRICATION

- A. Pipe Ends
  - 1. Ream and remove burrs after cutting pipe. Standard wall pipe ends shall be welded, threaded, cut grooved, or plain end.

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2. Thin wall pipe ends shall be plain end, welded or roll grooved in accordance with the fitting manufactures' recommendation.
  3. Threads shall be in accordance with ASME B1.20.1. Each thread on light wall pipe shall be gauged before the fitting is made-up.
- B. Grooved Ends
1. Pipe minimum thickness, squareness and out-of roundness shall be in accordance with the coupling manufacturers specifications.
  2. Pipe surface shall be free of indentations, projections, or roll marks from the end of the pipe to the groove.
- C. Welding
1. No field welding of sprinkler/standpipe piping shall be permitted.
  2. Headers risers, feed mains, cross mains and branch lines may be shop welded using acceptable welding fittings. Welding methods shall comply with all the requirements of AWS B2.1.
  3. Certified records shall be maintained upon the completion of each weld, welder shall stamp an imprint of their identification into the side of the pipe adjacent to the weld.

### 3.3 INSPECTION

- A. Investigate site conditions; verify utility locations and elevations before start of excavation.
- B. Discrepancies will be forwarded to Architect/Engineer before proceeding with construction

### 3.4 INSTALLATION

- A. A clean set of prints or shop drawings shall be maintained at the site and marked up to show any changes.
- B. Piping shall be installed above ceilings except in areas where there is no ceiling. Install piping in exposed areas as high as possible using necessary fittings and auxiliary drains to maintain maximum clear head room.
- C. Install hydraulically designed sprinkler system and associated accessories according to requirements of NFPA 13 and as shown on drawings.
- D. Install pipe and fittings according to recommendations of pipe manufacturer.
- E. Keep materials within listed temperature range to assure jointing in accordance with manufacturer's requirements.
- F. Pipe and fittings shall be of corresponding materials when assembled.
- G. For underground pipe, in lieu of thrust blocks; anchors and tie rods can be provided. Tie rods shall be 3/4" diameter steel rod. Clamps shall be 3/8" thick by 2" wide steel. Each clamp shall be secured with four 5/8" diameter bolts.
- H. Apply asphaltum or corrosion inhibitive paint to tie rods, clamps and bolts of underground pipe.
- I. Provide readily removable fittings at end of cross-mains. Minimum size of flushing connection shall be 2".
- J. Provide test connection for each flow switch.

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- K. Discharge test connections inside building to receptacles provided as part of plumbing system or to drain standpipe.
- L. Drain line detailed adjacent to sprinkler risers shall be considered as part of Sprinkler System from combination test/auxiliary drain valve for each zone or sub-zone shown on plans to plumbing receptacle.
- M. Provide auxiliary drains at low points of systems. Where trapped section of pipe exceeds 5 gallons, drain shall consist of, as a minimum: valve, 3/4" brass nipple with 3/4" male hose threads, and cap.
- N. Identify valve with brass tag denoting which flow switch is being tested, when test valves are located remote from flow switch.
- O. Clamp-on or saddle type fittings are not allowed. Outlet fittings inserted into holes drilled into piping or pipe-o-lets are not allowed.
- P. Provide reducing fittings or provide shop fabricated weld-o-lets to change pipe sizes in sprinkler/standpipe systems. No bushings or grooved reducing couplings, such as Victaulic Style 750, are allowed.
- Q. Feed sprinkler heads, installed in finished ceilings, with swing joint or return bend arrangement for final positioning in ceiling grid pattern during construction phases. Sprinklers are required to be installed in the center of ceiling tiles.
- R. Provide minimum 1" outlets with sprigs or drops for sprinklers located in shelled spaces.
- S. Provide tamper switch on each shutoff valve.
- T. Provide locking device with each shutoff valve to prevent inadvertent closing of valve. Keys shall be indexed to identify valve location.
- U. Install sprinkler heads as recommended by manufacturer. Sprinklers shall be set level and at locations to avoid interference with spray pattern of sprinkler. When ducts and lights are obstructions to sprinkler distribution, provide additional heads beneath obstruction.
- V. Make joints of threaded pipe by cutting pipe square and reaming inside.
- W. Coat exposed threads with corrosion inhibitive paint. Use joint compound sparingly.
- X. Install joints for mechanical coupled pipe according to manufacturer's recommendations. Use manufacturer's gasket lubricant sparingly.
- Y. Pipe shall be cut grooved for Schedule 40 steel pipe or roll grooved for Schedule 10 steel pipe as specified by coupling manufacturer.
- Z. Welded joints shall be made in fabrication shop. No welding allowed at project site.
- AA. Hang pipe from building members using concrete inserts or beam clamps. Expansion type inserts may be used for branch piping.
- BB. Support piping in accordance with NFPA 13 Seismic Anchorage and Restraints, and in accordance with State and Local seismic restraint requirements.
- CC. Provide seismic restraint details and calculation with sprinkler shop drawings.

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- DD. Provide pressure gauges as required in manufacturer's installation instructions, and as required per NFPA.
- EE. Generally install capped tees in lieu of couplings for future connections.

### 3.5 SPRINKLERS

- A. General
  - 1. Sprinklers below ceilings off of exposed piping shall be listed and approved regular bronze upright type, in upright position. Listed and approved regular bronze pendent type may be used where necessary due to clear height requirements, duct interference, etc.
  - 2. Pendent sprinklers shall be installed where suspended ceilings are located shall be concealed type and center of tile.
  - 3. Sprig-ups shall be provided wherever necessary to provide proper deflector distances in accordance with NFPA 13 requirements.
  - 4. Provide flex head for suspended T-bar ceiling to accommodate 1" minimum seismic movement.
  - 5. Provide sprinkler below duct with minimum width 4 ft and above.
- B. Sprinkler Guards and Water Shields
  - 1. Provide guards on sprinklers within 7 feet of finished floor or wherever sprinklers may be subject to mechanical damage.
- C. Drains
  - 1. Provide main drain valves at system control valves, sized in accordance with NFPA 13 and AHJ requirements that extend piping to exterior.
  - 2. Provide all auxiliary drains where necessary.
  - 3. Pipe all drains and auxiliary drains to locations where water drained will not damage stock, equipment, vehicles, planted areas, etc., or injure personnel.
  - 4. Plugs used for auxiliary drains shall be brass.
  - 5. All piping and fittings downstream of drain valve and gang drain shall be hotdipped galvanized.
  - 6. The Contractor shall comply with all water discharge restrictions.

### 3.6 VALVES

- A. General
  - 1. Valves shall be installed with sufficient clearance for operation, testing and maintenance.
  - 2. Where wafer bodied valves are used, they shall be installed so that the discs do not interfere with other components.
- B. Control valves shall be installed so that valve position indicator is visible.
- C. Drain, test, and trim valves.
  - 1. Valves shall be installed no more than 7 feet 0 inches above the finished floor and shall be accessible.
- D. Backflow Preventers
  - 1. Install backflow preventers of reduced pressure detector assembly type with clearances required by AHJ and in compliance with manufacturer's recommendations for inspection, testing and maintenance.
- E. Floor Control Valves

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1. Provide floor control valve assemblies within the stair enclosure on all floors. Each floor control valve assembly shall be equipped with a control valve, tamper switch, flow switch, inspector's test/drain trim assembly, pressure-relief valve not less than ½-inch in size and set to operate at 175 psi, and pressure-reducing device set at
2. Pressure-reducing valves will require discharging to a gang drain.

### **3.7 FIRE DEPARTMENT CONNECTIONS**

- A. Install with centerline of inlets neither less than 18 inches nor more than 48 inches above the finished grade or pavement.
- B. Piping from fire department connection to check valve shall be hot-dipped galvanized.

### **3.8 PRESSURE GAUGES**

- A. Gauges shall be located where not subject to freezing.
- B. Gauges shall be provided vertically, with three-way valve with 1/4-inch plugged outlet, and as follows:
  1. Above and below wet system riser check valves.
  2. At each water supply and inlet of floor control valve.
  3. At inlet and outlet of each pressure-reducing floor control valve.
  4. At inlet of each pressure-reducing fire hose valve.
  5. At top of each standpipe.

### **3.9 HANGERS, SUPPORTS, AND EARTHQUAKE BRACING**

- A. General
  1. All piping must be substantially supported from building structure and only approved types of hangers shall be used. Piping lines under ducts shall not be supported from duct work, but shall be supported from building structure with trapeze hangers where necessary or from steel angles supporting duct work in accordance with NFPA 13.
  2. All thread rods shall not be bent.
  3. Hanger components shall be ferrous.
  4. Powder driven studs shall be specifically listed for use in the required seismic zone.
- B. Feed and Cross Mains
  1. Install at least one hanger per length of pipe up to 8 feet in length joined by grooved couplings.
  2. Use flexible couplings where more than two couplings are used per run.
- C. Risers
  1. Standpipes shall be supported at lowest level and alternate levels above using riser clamp.
  2. Provide flexible couplings in standpipe.
- D. System Headers
  1. Install pipe saddle supports complete with flange bolted to floor.
- E. Earthquake Protection
  1. Install flexible joints and sway braces in accordance with NFPA 13, Section 9.3.

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### **3.10 SLEEVINGS, WALL AND FLOOR PENETRATIONS**

- A. Set Schedule 40 sleeves in place for all pipes passing through openings in fire resistance rated construction when required by UL listing for fire stopping method utilized.
- B. Provide clearance between the sprinkler piping and sleeves in accordance with NFPA and FM. The space between sleeve and pipe shall be filled with noncombustible, UL listed fire stopping materials. Provide chrome wall plates at each side of wall.
- C. Sleeves through floors shall be watertight. Penetrations through fire rated construction shall be adequately fire stopped to maintain the fire resistance rating required.

### **3.11 SIGNS**

- A. Valves
  - 1. Secure to each valve with corrosion resistant wire or chain, sign stating, "Control valve."
- B. Hydraulic Design Information
  - 1. Secure to each system riser with corrosion resistant fasteners.

### **3.12 WATER FLOW ALARMS AND SUPERVISORY DEVICES**

- A. Alarm Bells
  - 1. Electric bells and wiring diagrams shall be delivered to the alarm contractor for installation and wiring.
- B. Alarm and Supervisory Switches
  - 1. Deliver wiring diagrams to alarm contractor.
  - 2. Install alarm water flow switches in accordance with switch and valve manufacturers' instructions.
  - 3. Install and adjust valve supervisory switches in accordance with switch manufacturers' instructions.

### **3.13 INSPECTOR'S TEST**

- A. Provide inspector's test connections, as specified in NFPA 13, at required points for testing each waterflow alarm device. Special discharge nozzle shall have same size orifice as smallest orifice sprinklers installed.
- B. Provide 1-inch sight glass if inspector's test discharge cannot be readily observed while operating valve.
- C. Pipe all inspector's test connections discharging to atmosphere to location where water drained will not damage stock, equipment, vehicles, planted areas, etc., or injure personnel.
- D. Splash blocks shall be provided where inspector's test discharge could produce damage to surroundings.
- E. All pipe and fittings downstream of inspector's test valve shall be galvanized.

### **3.14 STANDPIPE IN BUILDINGS DURING CONSTRUCTION**

- A. Temporary or permanent standpipes shall be provided during construction (if required by the AHJ), extending up with each floor as construction progresses. Installation of standpipes in

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buildings under construction shall comply with the appropriate sections of CBC Section 905.10.

### 3.15 SYSTEM ACCEPTANCE

#### A. Tests

1. General system test shall be coordinated with the Owner's representatives for training and witnessed by the AHJ and Owner's commissioning agent. Problems noted during testing such as air or water leaks, difficulty in operating valves, alarm failures, etc. shall be corrected before the Contractor leaves the job.
2. Hydrostatically test all piping, including fire department connections between the check valve and connection, at 200 psi for two hours. If the highest static pressure at the lowest point in the system exceeds 150 psi, the system shall be tested at 50 psi more than the highest static pressure.
3. Flow Tests
  - a. Main drain shall be opened wide until pressure stabilizes then slowly closed, noting and recording flowing (residual) and static (non-flow) pressure.
  - b. Pressure-reducing floor control valves and fire hose valves shall be tested noting inlet and outlet pressures under non-flowing and flowing conditions. Record results.
  - c. Pilot-operated pressure-reducing valves shall be tested as specified in (b). Adjust pilot for design pressures.
  - d. Backflow preventers shall be forward-flow tested.
4. Pipe shall not be concealed until satisfactorily pressure tested.
5. Conduct drain test. Record static pressure and residual pressure per NFPA 13.
6. Owner's representative or engineer may witness tests. Contractor shall notify Owner and Engineer a minimum of 3 days in advance to allow for participation.
7. Log of tests shall be kept at job site and shall identify:
  - a. Who performed test.
  - b. Time of test.
  - c. Date of test.
  - d. Section of system tested.
  - e. Results of test.
  - f. Along with completed Contractor's Material and Test Certification form(s) from NFPA 13 and NFPA 14.
8. Operate flow switches to test that signals are transmitted to Fire Alarm Control Panel.
9. Include test for tamper switches.

#### B. Valve Operation

1. Operate each valve through its entire range. Adjust valve packing glands.
  - a. Hose valves shall be capped during the test.
2. Threads for hose valve/wall hydrant outlets and fire department inlets shall be verified to conform to those used by the AHJ.

#### C. Water Flow and Supervisory Devices

1. Coordinate testing of electric components with the alarm contractor.
2. Each water flow device shall be tested in accordance with NFPA 72 by opening the inspectors test or alarm test valve.
3. Each valve supervisory device shall be tested by operating the valve wheel/crank.
4. Verify all signals have been noted by the fire alarm control panel and each audible alarm device operates.

#### D. Contractor's material and test certificates shall be completed for each system/floor and signed by the Contractor and witnessed by the Owner's representative/AHJ.



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- E. Training
  - 1. General – In addition to the tests required in Parts A through C and witnessed by the Owner's representative(s), conduct one/two hour training sessions to familiarize the representatives with all operating features of the system, including control valve, drain and test valve locations and operations.
  - 2. Provide Owner's representatives with:
    - a. A small scale plan of the system/building showing locations of control, drain and test valves.
    - b. Component manufacturers' inspection and testing manuals.
    - c. A copy of the latest version of NFPA 25, California Edition.
  - 3. Spare Parts
    - a. Provide 12 spare sprinklers of all types and ratings that are installed, in a steel cabinet complete with special sprinkler wrenches. Install cabinet as directed by Owner.

### **3.16 ADJUSTMENT AND CLEANING**

- A. Cleaning: Flush all piping in accordance with NFPA Standards for test procedures.
- B. Ensure underground feed pipe has been flushed, to clear out construction debris, prior to connecting aboveground fire protection system to it.
- C. Maintain the premises free from accumulation of waste materials or rubbish caused by this work

### **3.17 BONDING**

- A. Provide underground cast iron and underground ductile iron pipe with metallic bond at each joint.
- B. Bond wire shall be type RHW-USE size 1/0 neoprene-jacketed copper conductor shaped to stand clear of joint.

**END OF SECTION 21 13 13**

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## **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, crawlspace, 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**

#### **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

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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).

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## **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.

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2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

### **PART 3 EXECUTION**

#### **3.1 PLUMBING DEMOLITION**

- A. Refer to Division 01 Section "Cutting and Patching" 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.
  5. Prior to any Disconnection/Demo/Connection of any wet utilities, this work shall be coordinated with the AHJ.
- 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 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.

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- 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.

### 3.3 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.

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- 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.

### 3.4 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.

### 3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

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- 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.

### **3.6 CONCRETE BASES**

- A. 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."

### **3.7 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.

### **3.8 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.



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**END OF SECTION 22 05 00**

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## **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.

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## **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.

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- 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.
    - a. 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.

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- 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.

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## 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.

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- 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**

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## **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.



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## **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.

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- 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.

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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.

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### 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**

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## **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.

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## 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.

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- 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**

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## **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.
  - 9. Sight flow indicators.
- B. Related Requirements:
  - 1. Section 221119 "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. Trerice, 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.



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- 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.

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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. Terice, 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.

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## 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. Trerice, 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.

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## 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.

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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.

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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**

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## **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.

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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:



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- 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:

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- 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:
  - 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.

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- 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.

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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.

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- 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:

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- 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.

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- 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.

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- 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.



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## 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.

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- 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.

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- C. Iron, Single-Flange Butterfly Valves with Stainless-Steel 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, 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.

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## **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.

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- G. 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.

### 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:

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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.

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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**



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## **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 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
  - 2. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
  - 3. Section 220548 "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.



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- 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:

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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.

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- 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.

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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.

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- 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.

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- 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.

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### **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.



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- 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.



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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-joist 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.

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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

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## **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.

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- 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."

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- 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:

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- 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:



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- 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.

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- 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.



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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.

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- 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.

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## **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.

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- 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 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.

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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**

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## **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.

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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 Sevice's 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.

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- 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.



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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.

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## **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 099100 "Painting."
- 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:

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- a. Background: Safety blue.
  - b. Letter Colors: White.
- 3. Domestic COLD Water Piping
  - a. Background: Safety blue.
  - b. Letter Colors: White.
- 4. Domestic HOT Water Supply/Return Piping
  - a. Background: Safety red.
  - b. Letter Colors: White.
- 5. Natural Gas Piping
  - a. Background: Safety yellow.
  - b. Letter Colors: Black.
- 6. 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**

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## **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.

#### **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.

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- 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.

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## 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. 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.
- H. Mineral-Fiber, Preformed Pipe Insulation:

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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.

## 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.
- B. 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.
  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.
- 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. 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:



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- 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.
- E. 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:



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- 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 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

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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.

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- 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.

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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.

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- 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.

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- 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-resistive 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.



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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 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.

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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.

### 3.8 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.

### 3.9 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099100 "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. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

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### 3.10 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."

### 3.11 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.

### 3.12 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. Mineral-Fiber, Preformed Pipe Insulation, Type I: 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. Mineral-Fiber, Preformed Pipe Insulation, Type I: 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. 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.

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- b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

### **3.13 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.

### **3.14 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 19**

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## **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. Pressure regulators.
  - 6. Service meters.
  - 7. 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.

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- 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.

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- 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:



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- 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.



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- 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 2 and 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.

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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.

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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.

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- 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.

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- 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 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.

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- 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.

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- 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.

## 2.7 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:



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- 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.

## 2.8 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. 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:



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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.

## 2.9 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.

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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.

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- 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."

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### **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 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.

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- 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 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hangers and supports specified in Section 220529 "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 220553 "Identification for Plumbing Piping and Equipment" for piping and valve identification.

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- 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 099100 "Painting" for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, 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, 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 033000 "Cast-in-Place Concrete."

### 3.13 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:

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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 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.

### **3.15 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.

### **3.16 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.



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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.

### **3.17 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.

### **3.18 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.

### **3.19 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.



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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**

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## **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 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.

#### **2.2 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.

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- 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.

## 2.3 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.

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- 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.

## 2.4 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.

## 2.5 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.
- B. Form: Sheet or tube.
- C. Color: Black or natural.

## 2.6 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.

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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.

## 2.7 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:

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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.

## **PART 3 EXECUTION**

### **3.1 EARTHWORK**

- A. Comply with requirements in Section 312000 "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."

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- 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 221119 "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 220548 "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 220519 "Meters and Gages for Plumbing Piping."
- T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

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- U. 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."
- V. 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."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "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.



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### **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 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "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.

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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 220553 "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:

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- 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:

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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.

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- 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.

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**END OF SECTION 22 11 16**

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## **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 220519 "Meters and Gauges for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
  - 2. Section 221116 "Domestic Water Piping" for water meters.
  - 3. Section 224713 "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.

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## **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.



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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.

## 2.4 BACKFLOW PREVENTERS

### A. 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.

### B. 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.

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- C. 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.

## 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.

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## 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. Primary, Thermostatic, Water Mixing Valves:

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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.
- B. 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.
- C. 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.

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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. 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.

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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.

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## 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).



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- 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.



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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. Automatic Water Shutoff Valves: Test for signal strength before valve installation. Install automatic shutoff valve downstream from main domestic water shutoff valve and downstream from fire sprinkler system supply. Install valve controller in an accessible location with sensors in areas where water is likely to accumulate.
- E. Balancing Valves: Install in locations where they can easily be adjusted.
- F. 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.
- G. Y-Pattern Strainers: For water, install on supply side of each control valve, water pressure-reducing valve, solenoid valve and/or pump.
- H. 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."
- I. Water-Hammer Arresters: Install in water piping according to PDI-WH 201.
- J. 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.
- K. 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.

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- L. 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.

### **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. Dual-check-valve backflow preventers.
  - 6. Reduced-pressure-detector, fire-protection, backflow-preventer assemblies.
  - 7. Double-check, detector-assembly backflow preventers.
  - 8. Water pressure-reducing valves.
  - 9. Automatic water shutoff valves.
  - 10. Calibrated balancing valves.
  - 11. Primary, thermostatic, water mixing valves.
  - 12. Primary water tempering valves.
  - 13. Outlet boxes.
  - 14. Supply-type, trap-seal primer valves.
  - 15. 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.

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- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

**END OF SECTION 22 11 19**

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## **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.

#### **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.

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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.

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- 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.

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- 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:

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- 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."



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### 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 220548 "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.

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- 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 221319 "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 221319 "Sanitary Waste Piping Specialties."
  - 3. Install drains in sanitary waste gravity-flow piping.
    - a. Comply with requirements for drains specified in Section 221319 "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 220517 "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 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Z. Install escutcheons for piping penetrations of walls, ceilings, and floors.

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1. Comply with requirements for escutcheons specified in Section 220518 "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 220523 "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.

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- 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 221319 "Sanitary Waste 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." and Section 220548 "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.

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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.

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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.



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- 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.

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- 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**



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## **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. Cleanouts.
  - 2. Roof flashing assemblies.
  - 3. Through-penetration firestop assemblies.
  - 4. Miscellaneous sanitary drainage piping specialties.
  - 5. Floor drains.
- B. Related Requirements:
  - 1. Section 221423 "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. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene.
- D. PE: Polyethylene.
- E. PP: Polypropylene.
- F. PVC: Polyvinyl chloride.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. 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. 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.

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## **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 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.

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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.

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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.

## 2.3 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.

## 2.4 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.

## 2.5 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.

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- 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.
  - 5. Maximum Overcurrent Protection: <Insert number> A.

## 2.6 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.

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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.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Equipment Mounting:
  1. Comply with requirements for vibration-isolation and seismic-control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
  2. Comply with requirements for vibration-isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."
- B. 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.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- G. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
  1. Comply with requirements in Section 078413 "Penetration Firestopping."
- H. Assemble open drain fittings and install with top of hub 1 inch or 2 inches above floor.
- I. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- J. 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.

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- K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- L. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- M. Install vent caps on each vent pipe passing through roof.
- N. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- O. Install wood-blocking reinforcement for wall-mounting-type specialties.
- P. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- Q. 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.
- R. Install trench drains at low points of surface areas to be drained.
  - 1. Set grates of drains flush with finished surface, unless otherwise indicated.
- S. 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.
- T. Install open drain fittings with top of hub 1 inch to 2 inches above floor.

### 3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "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. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- E. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

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- F. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

### **3.3 FLASHING INSTALLATION**

- A. Comply with requirements in Section 076200 "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 076200 "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. 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 220553 "Identification for Plumbing Piping and Equipment."

### **3.5 FIELD QUALITY CONTROL**

- A. 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.

**END OF SECTION 22 13 19**



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## **SECTION 22 16 19 DISINFECTION OF POTABLE WATER SYSTEM**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. This section includes the furnishing of all labor and materials for disinfection of the potable water system. Potable water systems are those systems which carry domestic water from the supply main without isolation of the branch by a backflow prevention device. Install all plumbing fittings and valves necessary to perform the disinfection.
- B. This section also includes the furnishing of all labor and materials to sample water in system following completion of procedure and provide bacteriological analysis of the water.

#### **1.2 QUALIFICATIONS**

- A. Disinfection: Disinfection shall be done by a commercial disinfection company approved by the College. Submit to the College's Representative the name of the proposed company for approval.
- B. Bacteriological Analysis: Water testing shall be done by a laboratory approved by the State Department of Health Services. Submit for approval the name of the proposed laboratory as well as the proposed number and location of samples.
- C. Provide a certificate of completion per Part B attached standard chlorination report which denotes the lines disinfected, the concentration applied and the amount and type of disinfection agent used, and that disinfection is in accordance with AWWA C-601 and State Health Department requirements.

### **PART 2 PRODUCTS**

#### **2.1 MATERIALS**

- A. Use an approved chlorine agent, applied in liquid form into the system being disinfected. Chlorine gas or a hypochlorite solution may be used to make up the disinfecting liquid.

### **PART 3 EXECUTION**

#### **3.1 PRELIMINARY PREPARATION OF THE SYSTEM**

- A. Provide within 3 feet of the supply main, an injection port for introducing the chlorine solution and a gate valve upstream from the injection port.
- B. There shall be no dead-end sections in the system exceeding 3 feet in length. All branches within the system shall lead to an outlet for bleeding and flushing.
- C. After final pressure tests, open each fixture or outlet to maximum flow and run until the discharge water is free from particulates.

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### **3.2 CHLORINATION PROCEDURE**

- A. Notify the College's Representative at least five working days prior to the start date of chlorination per Part A attached chlorination report.
- B. Install all fixtures to be served by the potable water system before start of chlorination.
- C. Prior to injection, place signs on each fixture being treated, reading "Heavily Chlorinated Water - Do Not Use."
- D. Introduce the chlorine into the supply stream at a rate to provide a uniform concentration of chlorine in the entire system. Maintain at least 50 ppm chlorine level at each fixture after a hold period of 24 hours. Do not exceed 150 ppm at any time.
- E. Draw the injected chlorine in the system through each outlet and fixture until the specified concentration level is reached. Then close all valves including the service cock and supply valve. Keep the system closed during the 24 hour hold period.
- F. The College will require a test for the residual concentration in the system at the end of 24 hours. Release no water from the system until these required samples are taken. A minimum concentration of 50 ppm of chlorine is required at all chosen sampling points.
- G. After approval to proceed, flush the system at a relatively high velocity to remove the injected chlorine to a concentration in the system of no more than 0.5 ppm above that in the normal supply.
- H. After approval to proceed, secure the entire system for at least three days prior to taking samples for bacteriological analysis.

### **3.3 SAMPLING AND NOTIFICATION**

- A. At the completion of the three day hold period, take bacteriological water samples with observation by the College's Representative.
- B. Sample bottles must be provided by the approved laboratory. After the samples have been collected, the College's Representative may allow temporary use of the water system pending results of the bacteriological analysis of the samples. The system cannot be used unless such allowance in writing is given.
- C. Upon completion of sampling, submit the certificate of completion to the College's Representative for approval.

### **3.4 ANALYSIS**

- A. Perform qualitative and quantitative bacterial analysis on the water samples and submit a laboratory report. The report must include the presence of any E. Coli bacteria in a 100 ml sample (this must be negative to be acceptable) and a total plate count of bacteria per cc of the sample (this must be less than 100, or equal to the supply).

### **3.5 FINAL ACCEPTANCE**

- A. Upon satisfactory completion of all procedures and receipt of acceptable bacteriological results, written approval of the system will be provided by the College's Representative per Part C attached standard chlorination report. Failure to fully comply with the above

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procedures will result in a requirement to repeat the procedure until acceptable results are achieved, at no additional cost to the College.

**END OF SECTION 22 16 19**

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## **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. Laminar-flow, faucet-spout outlets.
  - 10. Lavatory and Sink Supply Fittings.
  - 11. Lavatory and Sink Waste Fittings.
  - 12. Grout.
  - 13. Supports.
- B. Related Requirements:
  - 1. Section 224713 "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.

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3. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

## **PART 2 PRODUCTS**

### **2.1 PLUMBING FIXTURES**

- A. Plumbing fixtures and accessories provided in a toilet room or bathing room required to comply with CBC Section 11B-213.2 shall comply with CBC Section 11B-213.3.
- B. Effective March 1, 2017, all single user-user toilet facilities shall be identified as Gender Neutral facilities by a door symbol that complies with CBC Sections 11B-216.8 and 11B-703.2.6.3. No pictogram, text or braille is required on the symbol. If tactile jamb signage is provided, the signage shall comply with the appropriate technical requirements of CBC Section Section 11B-703. Examples of appropriate designations are "ALL-GENDER RESTROOM," "RESTROOM" or "UNISEX RESTROOM." DSA BU 17-01.
- C. Accessible plumbing fixtures shall comply with all the requirements in CBC Division 6.
- D. Clearance around accessible water closets and in toilet comp[artments shall be 60 inches minimum measured perpendicular from the side wall and 56 inches minimum measured perpendicular from the rear wall per CBC Section 11B-604.3.1.
- E. Heights and location of all accessible fixtures shall be mounted according to CBC Sections 11B-602 through 11B-612.
- F. Accessible fixture controls shall comply with CBC Sections 11B-602.3 for drinking fountains, 11B-604.6 for water closets, 11B-604.9.5 for children's water closets, 11B605.4 for urinals, 11B-606.4 for lavatories and sinks, 11B-607.5 for bathtubs, 11B-608.5 for showers, and 11B-611.3 for washing machines and clothes dryers.

### **2.2 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; American Standard, Sloan Valve or Zurn Industries.
  3. 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.
  4. Flushometer Valve: See below.
  5. Toilet Seat: See below.
  6. Support: See below.
  7. 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:

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- 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.

## 2.3 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; American Standard, Sloan Valve or Zurn Industries.
  3. Standard: ASSE 1037.
  4. Type: Diaphragm.
  5. Minimum Pressure Rating: 125 psig.
  6. Features: Include integral check stop, backflow-prevention device and True Mechanical override switch.
  7. Material: Brass body with corrosion-resistant components.
  8. Exposed Flushometer-Valve Finish: Chrome plated.
  9. Panel Finish: Chrome plated or stainless steel.
  10. Style: Exposed.
  11. 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.
  12. 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.
  13. Consumption: 1.28 gal. per flush.
  14. Minimum Inlet: NPS 1.
  15. Minimum Outlet: NPS 1-1/4.

## 2.4 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; Bemis Manufacturing, Church Seats or American Standard.
  3. Standard: IAPMO/ANSI Z124.5.
  4. Material: Plastic.
  5. Type: Commercial, Heavy duty.
  6. Shape: Elongated rim, open front.
  7. Hinge: Self-sustaining, check-raising.

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8. Hinge Material: Noncorroding metal, stainless steel.
9. Seat Cover: Not required.
10. Color: White.

## 2.5 WALL-HUNG URINALS

- A. Urinals: Wall hung, back outlet, washout, accessible.
  1. Manufactures: Kohler "Brandon" model K-4991-ET or approved equal.
  2. Fixture:
    - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
    - b. Material: Vitreous china.
    - c. Type: Washout with extended shields.
    - d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
    - e. Water Consumption: Low.
    - f. Spud Size and Location: NPS 3/4, top.
    - g. Outlet Size and Location: NPS 2, back.
    - h. Color: White.
  3. Flushometer Valve: See below
  4. Waste Fitting:
    - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
    - b. Size: NPS 2.
  5. Support: Type I Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights..
  6. Urinal Mounting Height: Standard or accessible per Architectural drawings.

## 2.6 URINAL FLUSHOMETER VALVES

- A. Electronic flushometer valves:
  1. Manufacturer: Sloan "Royal" model 186-0.125-DBP-SF-ESS-TMO-HW or approved equal.
  2. Standard: ASSE 1037.
  3. Type: Diaphragm
  4. Minimum Pressure Rating: 125 psig.
  5. Features: Include integral check stop and backflow-prevention device and true mechanical override switch.
  6. Material: Brass body with corrosion-resistant components.
  7. Exposed Flushometer-Valve Finish: Chrome plated.
  8. Panel Finish: Chrome plated or stainless steel.
  9. Style: Exposed.
  10. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
  11. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
  12. Consumption: 0.125 gal. per flush.
  13. Minimum Inlet: NPS 3/4.
  14. Minimum Outlet: NPS 1-1/4.

## 2.7 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:

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- 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, 20 by 17 inches.
  - d. Faucet-Hole Punching: One hole.
  - e. Faucet-Hole Location: Top.
  - f. Color: White.
  - g. Mounting Material: Sealant.
- 3. Faucet: "Solid-Brass, Automatically Operated Lavatory Faucets" Article.

## 2.8 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

- A. Lavatory: Vitreous china, wall mounted, with back.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - b. Kohler Co.
    - c. Zurn Industries, LLC.
  - 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.
    - 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 II, concealed-arm lavatory carrier. Include rectangular, steel uprights.
  - 5. Lavatory Mounting Height: [Standard] [Handicapped/elderly according to ICC A117.1].

## 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, 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. 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.



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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, solid brass.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 0.35 gpm.
9. Mounting Type: Deck, concealed.
10. Spout: Rigid type.
11. Spout Outlet: Aerator type.
12. Drain: Not part of faucet.

## 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: No holes on fixture.
    - d. Color: White.
    - e. Mounting: NPS 3 P-trap standard with grid strainer inlet, cleanout, and floor flange.
    - f. Rim Guard: On front and sides.
  3. Faucet: Refer to Fixture Schedule on drawing P002.
  4. Support: Type II sink carrier.
  5. Lavatory Mounting Height: Refer to Architectural drawings for fixture heights.
- 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 or NPS 3 outlet.
    - f. Rim Guard: Coated wire.
  3. Faucet: <Insert sink-faucet designation from "Sink Faucets" Article>.

## 2.11 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.

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- 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.

## 2.12 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.

## 2.13 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.

## 2.14 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.

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- D. Packaging: Premixed and factory packaged.

## 2.15 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.

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- 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 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.

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- 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
- D. and Vent Piping."
- E. 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.

### **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 44 00**

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## **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.
- B. Sustainable Design Submittals:
  - 1. Product Data: For water consumption.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For drinking fountains to include in maintenance manuals.

### **PART 2 - PRODUCTS**

#### **2.1 DRINKING FOUNTAINS**

- A. Drinking Fountains with Bottle Filling station: Stainless steel, wall mounted.
  - 1. Stainless-Steel Drinking Fountains:
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Elkay Manufacturing Co.
      - 2) Filtrine Manufacturing Company.
      - 3) Halsey Taylor.
      - 4) Haws Corporation.
      - 5) Murdock Manufacturing; A Member of Morris Group International.
      - 6) Willoughby Industries.

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2. Standards:
  - a. Comply with ASME A112.19.3/CSA B45.4.
  - b. Comply with NSF 61 Annex G.
3. Type Receptor: On horizontal support.
4. Receptor Shape: Rectangular.
5. Back Panel: Stainless-steel wall plate behind drinking fountain.
6. Bubblers: One, with adjustable stream regulator, located on deck.
7. Bottle filler: Electronic Bottle Filler integrated into the drinking fountain
8. Bottle filler Green Ticker: Informs user of number of 20 oz. plastic water bottles saved from waste
9. Maximum water flow: 0.15 gpm.
10. Control: Push button.
11. Drain: Grid type with NPS 1-1/4 tailpiece.
12. Supply: NPS 3/8 with shutoff valve.
13. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 chrome-plated brass P-trap and waste.
14. Support: Type I water cooler carrier Type or II water cooler carrier.
15. Drinking Fountain Mounting Height: Bi-Level .

## 2.2 SUPPORTS

### A. Type I Water Cooler Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.

### B. Type II Water Cooler Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.

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## **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 off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- D. 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 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. 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 220518 "Escutcheons for Plumbing Piping."
- G. 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 079200 "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 221116 "Domestic Water Piping."
- C. Install ball or gate shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
- D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."



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**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**

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## **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

#### **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:

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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.

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## **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.

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- 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.

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#### **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.

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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.



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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

Not Applicable.



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## **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:

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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 Amershield 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:

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- 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.

**END OF SECTION 23 00 00**

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## **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, crawlspace, 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

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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.

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- 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

**END OF SECTION 23 05 00**

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## **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.

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- 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.

**END OF SECTION 23 05 13**



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## **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:
- D. 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.
  - 1. Shall be ISO-9002 certified.
  - 2. 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.
  - 3. 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.

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## **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.

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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 the capability of storable special custom user setting.
  3. Shall restart into a rotating motor operating in either the forward or reverse direction and match that frequency.
  4. Shall have adjustable soft stall (10% - 150%) which reduces frequency and voltage of the inverter to sustain a run in an overload situation.
  5. Shall have adjustable UL listed electronic overload protection (10% - 100%). The drive shall have a custom programmable volt/hertz pattern.
  6. Serial RS232C communication standard
  7. 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,
      - 1) Motor overload pre-alarm
      - 2) Undercurrent alarm
      - 3) Over current pre-alarm
      - 4) 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.
      - 1) Over current on the DC Bus during normal run trip, acceleration trip, or deceleration trip.
      - 2) Over voltage (130% of VFD's rated voltage) during normal (constant speed) run trip, acceleration trip, or deceleration trip.
      - 3) Under voltage (65% of the VFD's rated voltage) trip.
      - 4) Over temperature.
      - 5) Ground Fault either running or at start
      - 6) Emergency off trip message.
      - 7) RAM, ROM, CPU error
      - 8) Communication interruption error
      - 9) Output current detection circuit error
      - 10) Over torque trip
    - b. 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.

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**END OF SECTION 23 05 14**

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## **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**

- B. 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.
- C. Product Data: For each type of product indicated.

#### **1.3 INFORMATIONAL SUBMITTALS**

- D. Product Certificates: For each type of meter and gage, from manufacturer.

#### **1.4 CLOSEOUT SUBMITTALS**

- E. 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. Trerice, H. O. Co.
  - 2. Weiss Instruments, Inc.
  - 3. WIKA Instrument Corporation - USA.
- B. Standard: ASME B40.200.
- C. Case: V-shape design. cast aluminum.
- D. Fill type: Blue liquid
- E. Connector Type(s): Union joint, adjustable angle, lockable.

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- 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: NPT 1/2, NPT 3/4, or NPT 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. Trerice, 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.

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2. Sisco Manufacturing Company, Inc.
3. Trerice, 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 ¼ or NPS ½, 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

### 3.2 INSTALLATION

- A. Install thermometers in the following locations:
1. Inlet and outlet of fluid cooler.
  2. Inlet and outlet of boilers.
  3. Inlet and outlet of heat pump water coil.
  4. Entrance and exit of main building service.
- B. Install pressure gages in the following locations:
1. Inlet and outlet of fluid cooler.
  2. Inlet and outlet of boilers.
  3. Inlet and outlet of heat pump water coil.
  4. Discharge of each pressure-reducing valve.
- C. Install pressure/temperature plug in the following locations:

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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**



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## **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 230553 "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.

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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.

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- 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.

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- 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.

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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 CONDENSER-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.

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- 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**

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## **SECTION 23 05 29 HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Metal pipe hangers and supports.
  - 2. Trapeze pipe hangers.
  - 3. Fiberglass pipe hangers.
  - 4. Metal framing systems.
  - 5. Fiberglass strut systems.
  - 6. Thermal-hanger shield inserts.
  - 7. Fastener systems.
  - 8. Pipe stands.
  - 9. Equipment supports.
- B. Related Sections:
  - 1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
  - 2. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
  - 3. Section 233113 "Metal Ducts" for duct hangers and supports.

#### **1.2 REFERENCES**

- A. ASME B31.9 Building Services Piping
- B. MSS SP58 Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application and installation
- C. MSS SP-69 Pipe Hangers and Supports – Selection and Application
- D. MSS SP-89 Pipe Hangers and Supports – Fabrication and Installation Practices

#### **1.3 DEFINITIONS**

- A. ASCE: American Society of Civil Engineers
- B. ASME: American Society of Mechanical Engineers
- C. ASTM: America Society for Testing and Material
- D. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.
- E. MFMA: Metal Framing Manufacturers Association
- F. SEI: Structural Engineering Institute

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

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- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to Standard ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures.
  - 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.

## **1.5 ACTION SUBMITTALS**

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements".
- B. Product Data: For each type of product indicated including component cut sheets and pre-approved details.
- C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
  - 1. Trapeze pipe hangers.
  - 2. Metal framing systems.
  - 3. Fiberglass strut systems.
  - 4. Pipe stands.
  - 5. Equipment supports.
- D. 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. Design Calculations: Calculate requirements for designing trapeze hangers.

## **1.6 INFORMATIONAL SUBMITTALS**

- A. Welding certificates.

## **1.7 QUALITY ASSURANCE**

- A. Structural Steel 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 current ASME Boiler and Pressure Vessel Code.

## **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 HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE 7.



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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 or hot dipped.
  3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
  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.
- 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 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 stainless steel.

## 2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, 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. Description: Shop or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
  2. Standard: MFMA-4.
  3. Channels: Continuous slotted steel channel with in-turned lips.
  4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
  5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
  6. Metallic Coating: Electroplated zinc, Mill galvanized, In-line, hot galvanized or Mechanically-deposited zinc.
- B. Non-MFMA Manufacturer Metal Framing Systems:
  1. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
  2. Standard: Comply with MFMA-4.
  3. Channels: Continuous slotted steel channel with in-turned lips.
  4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

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5. Hanger Rods: Continuous-thread rod, nuts, and washer made of PVC coated carbon steel, hot dipped galvanized carbon steel or stainless steel.

## **2.5 VERTICAL RISER CLAMPS FOR INSULATED PIPES**

- A. Vertical Riser Clamps for Insulated Steel Pipes:
  1. Manufacturer shall be Pipe Shields Inc. Model E2100 or equal.
  2. Carbon steel pipe material, steel straps and base that is compliance with ASTM A36.
  3. Insulation shall be calcium silicate, asbestos free, treated with water repellent.
  4. Jacket shall be galvanized steel that is in compliance with ASTM A-527.
  5. Fasteners shall comply with ASTM A-307 plated.
  6. Coating shall be primer coated.
- B. Vertical Riser Clamps for Insulated Copper Pipes:
  1. Manufacturer shall be Hydra-Zorb Titan Riser Clamp or equal.
  2. 25/50 flame spread/smoke spread index.
  3. Eliminates insulation compression.
  4. Crush resistant.
  5. Vertical load rating up to 2400 lbs.

## **2.6 THERMAL-HANGER SHIELD INSERTS**

- A. Manufacturers
  1. Pipe Shields Inc.
  2. Pittsburg Corning Foamglas ONE
  3. ITW Insulation Systems TRYMER 2000 XP
- B. Cold Piping: Insulation-Insert Material - 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. Hot Piping: Insulation-Insert Material - 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.

## **2.7 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.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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## **2.8 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: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
  - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
  - 2. Base: Stainless steel.
  - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
  - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
  - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
  - 2. Bases: One or more; plastic.
  - 3. Vertical Members: Two or more protective-coated-steel channels.
  - 4. Horizontal Member: Protective-coated-steel channel.
  - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- 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.

## **2.9 EQUIPMENT SUPPORTS**

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## **2.10 MISCELLANEOUS MATERIALS**

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Non-staining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

## **PART 3 EXECUTION**

### **3.1 HANGER AND SUPPORT INSTALLATION**

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

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- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. 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. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.
- E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- F. 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.
- G. 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.
- 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:

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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 same thickness as piping insulation.

### 3.2 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.

### 3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for 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.

### 3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

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- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

### 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 a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099113 "Exterior Painting" Section 099123 "Interior Painting" and Section 099600 "High Performance Coatings."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

### 3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 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 finish.
- 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 corrosion-resistant attachments for hostile environment applications.
- G. Copper Pipe or Tubing
1. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
  2. Or use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. 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.



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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 might occur.
  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 might occur.
  19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
  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 might occur and vertical adjustment is not necessary.
  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 might be required in addition to expansion and contraction.
- J. 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 non-insulated pipe risers NPS 3/4 to NPS 24.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of non-insulated pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
  3. Insulated piping shall use vertical riser clamps for insulated pipe.
- K. 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, 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.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

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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.
- M. 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.
- N. 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



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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.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

**END OF SECTION 23 05 29**

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## **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. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme. See paragraph 2.7.B.
- E. 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:

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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

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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.

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## **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.
- C. Provide equipment label on in the space on the t-bar ceiling to note WSHP locations above the ceiling.

### **3.4 PIPE LABEL INSTALLATION**

- A. Piping Color-Coding: Painting of piping is specified in Section 099123 "Interior Painting"
- B. 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. Within one foot of each valve and control device.
  - 2. Near each branch connection and riser takeoff.
  - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  - 4. Near major equipment items and other points of origination and termination.
  - 5. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 6. Spaced at maximum intervals of 20 feet along each run, but not less than once in each room at entrance and exit of each concealed space.
  - 7. On piping above removable acoustical ceilings.
- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- D. Pipe Label Color Schedule:
  - 1. Condenser-Water Piping:
    - a. Background Color: Green.
    - b. Letter Color: White.
  - 2. Refrigerant Piping:
    - a. Background Color: Yellow.
    - b. Letter Color: Black.

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### **3.5 VALVE-TAG INSTALLATION**

- A. Install tags on valves and control devices in piping systems, except valves within factory-fabricated equipment units; faucets; convenience and lawn-watering hose connections. 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. Condenser Water: 2 inches, round.
    - b. Hot Water: 2 inches, round.
    - c. Refrigerant: 2 inches, round.
  - 2. Valve-Tag Color:
    - a. Condenser Water: Natural.
    - b. Hot Water: Natural.
    - c. Refrigerant: Natural.
  - 3. Letter Color:
    - a. Condenser Water: Black.
    - b. Hot Water: Black.
    - c. Refrigerant: Black.
- C. All above and below grade and interior and exterior valves shall be tagged. Submit valve tag chart to the Owner Representative for review and approval at the completion of the project.

### **3.6 WARNING-TAG INSTALLATION**

- A. Write required message on, and attach warning tags to, equipment and other items where required.

**END OF SECTION 23 05 53**

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## **SECTION 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Balancing Air Systems:
    - a. Variable-air-volume systems.
  - 2. Balancing Hydronic Piping Systems:
    - a. Variable-flow hydronic systems.
  - 3. Testing, Adjusting, and Balancing Equipment:
    - a. Heat exchangers.
    - b. Motors.
    - c. Heat-transfer coils.
    - d. 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."

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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."



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## **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,"

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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.

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- 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.

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- 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.

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- 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.

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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.



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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.



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- 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:

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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.

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- 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:

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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

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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.

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- 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.

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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.



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- 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:



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- 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):

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- 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.

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- 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.

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- 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**

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## **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. Condenser-water piping.
  - 2. Air-vent piping.
  - 3. 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. Condenser-Water Piping 125 psig at 200 deg F.
  - 2. Air-Vent Piping: 200 deg F.
  - 3. 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.
- B. 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.

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## 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.

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## 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.

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- 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 ½
  - 5. Discharge Connection: NPS ¼
  - 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:



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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.

## **PART 3 EXECUTION**

### **3.1 PIPING APPLICATIONS**

- A. Condenser-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.
- B. Condenser-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.
- C. Air-Vent Piping:
1. Inlet: Same as service where installed.
  2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- D. 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**

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## **SECTION 23 21 16 HYDRONIC PIPING SPECIALTIES**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section includes:
  - 1. Hydronic specialty valves.
  - 2. Air-control devices.
  - 3. Strainers.
  - 4. Connectors.

#### **1.2 ACTION SUBMITTALS**

- A. Submittals shall be formatted per Section 230000 "General Mechanical Requirements".
- B. Product Data: For each type of product:
  - 1. Include construction details and material descriptions for hydronic piping specialties.
  - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
  - 3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

#### **1.3 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.

#### **1.4 MAINTENANCE MATERIAL SUBMITTALS**

- A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

#### **1.5 QUALITY ASSURANCE**

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- B. 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 HYDRONIC SPECIALTY VALVES**

- A. Bronze, Calibrated-Orifice, Balancing Valves:
  - 1. Manufacturers:
    - a. Bell & Gossett, A Zylem brand.
    - b. Armstrong Pumps, Inc.
    - c. TACO Comfort Solutions, Inc.
  - 2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
  - 3. Ball: Brass or stainless steel.
  - 4. Plug: Resin.
  - 5. Seat: PTFE.
  - 6. End Connections: Threaded or socket.
  - 7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
  - 8. Handle Style: Lever, with memory stop to retain set position.
  - 9. CWP Rating: Minimum 125 psig.

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10. Maximum Operating Temperature: 250 deg F.
- B. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
  1. Manufacturers:
    - a. Bell & Gossett, A Zylem brand.
    - b. Armstrong Pumps, Inc.
    - c. TACO Comfort Solutions, Inc.
  2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
  3. Ball: Brass or stainless steel.
  4. Stem Seals: EPDM O-rings.
  5. Disc: Glass and carbon-filled PTFE.
  6. Seat: PTFE.
  7. End Connections: Flanged or grooved.
  8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
  9. Handle Style: Lever, with memory stop to retain set position.
  10. CWP Rating: Minimum 125 psig.
  11. Maximum Operating Temperature: 250 deg F.
- C. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
  1. Manufacturers:
    - a. Conbraco Industries, Inc.
    - b. Watts Industries, Inc.; Watts Regulators.
    - c. Zurn-Wilkins.
  2. Body: Bronze or brass.
  3. Disc: Glass and carbon-filled PTFE.
  4. Seat: Brass.
  5. Stem Seals: EPDM O-rings.
  6. Diaphragm: EPT.
  7. Low inlet-pressure check valve.
  8. Inlet Strainer: stainless steel removable without system shutdown.
  9. Valve Seat and Stem: Noncorrosive.
  10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- D. Diaphragm-Operated Safety Valves: ASME labeled.
  1. Manufacturers:
    - a. Conbraco Industries, Inc.
    - b. ITT McDonnell & Miller Div.; ITT Fluid Technology Corp.
    - c. Kunkle Valve Division.
    - d. Spence Engineering Company, Inc.
  2. Body: Bronze or brass.
  3. Disc: Glass and carbon-filled PTFE.
  4. Seat: Brass.
  5. Stem Seals: EPDM O-rings.
  6. Diaphragm: EPT.
  7. Wetted, Internal Work Parts: Brass and rubber.
  8. Valve Seat and Stem: Noncorrosive.
  9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

## 2.2 AIR-CONTROL DEVICES

- A. Manual Air Vents:
  1. Body: Bronze body ball valve with stainless steel ball, NPS 1/2.
  2. CWP Rating: 150 psig.

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3. Maximum Operating Temperature: 225 deg F.
- B. Automatic Air Vents:
  1. Manufacturers:
    - a. Bell & Gossett No. 87.
    - b. Spirotherm Spirotap Model VTP.
  2. Body: Brass or bronze.
  3. Internal Parts: Nonferrous.
  4. Operator: Noncorrosive metal float.
  5. Inlet Connection: NPS 1/2.
  6. Discharge Connection: NPS 1/4 or 1/2.
  7. CWP Rating: 150 psig.
  8. Maximum Operating Temperature: 240 deg F.
- C. Bladder-Type ASME Expansion Tanks:
  1. Manufacturers:
    - a. Bell & Gossett Series B.
    - b. Wessels Tank Company Type NLA.
    - c. Amtrol L Series.
  2. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
  3. Provide with seismic restraint.
  4. Bladder: Heavy duty Butyl securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
  5. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
- D. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
- E. Coalescing-Type Air and Dirt Separators:
  1. Manufacturers:
    - a. Bell & Gossett Model CRS.
    - b. Armstrong Model DAS.
    - c. Amtrol.
  2. Tank: Fabricated steel tank; ASME constructed and stamped for 125-psig working pressure and 450 deg F maximum operating temperature.
  3. Coalescing Medium: Stainless steel.
  4. Air Vent: Threaded to the top of the separator.
  5. Inline Inlet and Outlet Connections: Threaded for NPS 2 and smaller; Class 150 flanged connections for NPS 2-1/2 and larger.
  6. Blowdown Connection: Threaded to the bottom of the separator.
  7. Size: Match system flow capacity.

## 2.3 STRAINERS

- A. Y-Pattern Strainers up to NPS 1.5:
  1. Manufacturers:
    - a. The Metraflex Company.
    - b. Keckley.
    - c. Mueller Steam Specialty.
  2. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
  3. End Connections: Threaded.
  4. Strainer Screen: 40 mesh stainless-steel screen.
  5. CWP Rating: 125 psig.
- B. Y-Pattern Strainers NPS 2 and Larger:
  1. Manufacturers:
    - a. The Metraflex Company Model LPD.
    - b. Or Engineer approved equal.

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2. Y-strainer shall be of low pressure drop design with the following Cv values:
    - a. 2" Pipe 120
    - b. 2.5" Pipe 160
    - c. 3" Pipe 236
    - d. 4" Pipe 460
    - e. 6" Pipe 952
    - f. 8" Pipe 1,580
    - g. 10" Pipe 2,424
    - h. 12" Pipe 3,200
  3. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection. Strainer shall be suitable for horizontal and vertical mounting.
  4. End Connections: Flanged ends.
  5. Strainer Screen: Stainless-steel, screen perforations shall be:
    - a. For liquid service for NPS 2 – 3, perforation shall be 0.045"
    - b. For liquid service for NPS 4 – 12, perforation shall be 0.125"
  6. Pressure Taps: Provide with inlet and outlet pressure plugs.
  7. CWP Rating: 125 psig.
- C. Basket Strainers:
1. Manufacturers:
    - a. The Metraflex Company.
    - b. Keckley.
    - c. Mueller Steam Specialty.
  2. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
  3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  4. Strainer Basket: Stainless steel material with perforated sides and solid bottom. Basket to be provided with an integral handle for removal and size of perforations to be appropriate for the media. For water service, 2" thru 3" sizes to have .045 perforations, 4" thru 16" to have .125 perforations.
  5. CWP Rating: 125 psig.

## 2.4 CONNECTORS

- A. Spherical, Rubber, Flexible Connectors:
1. Manufacturers:
    - a. The Metraflex Company.
    - b. Keckley.
    - c. Mueller Steam Specialty.
  2. Body: Fiber-reinforced rubber body.
  3. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
  4. Performance: Capable of misalignment.
  5. CWP Rating: 150 psig.
  6. Maximum Operating Temperature: 250 deg F.
- B. Pump Suction Diffusers:
1. Manufacturers:
    - a. The Metraflex Company Suction Diffuser Flex.
    - b. Or Engineer approved equal.
  2. Stainless hose, flexible braid, integral rotational vanes, 90° reducing elbow and flanged connection.
    - a. Flexible hose section to be 304 stainless steel, close pitch, annular corrugated hose with a type 304 braided outer covering.
    - b. End connections to be ANSI class 150 carbon steel plate flanges.
    - c. Overall length to allow for a minimum of 6" intermittent flexing.
  3. Connectors shall be located upstream of the inlet elbow, and incorporate specially designed stationary vanes that impart a rotational motion as the fluid enters the elbow.

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Vanes to be capable of counteracting elbow induced turbulence, enabling the fluid to negotiate the turn uniformly, and exit with a flat velocity profile.

- C. Pump Discharge Connections:
  - 1. Manufacturers:
    - a. The Metraflex Company Vane Flex.
    - b. Or Engineer approved equal.
  - 2. Stainless hose, flexible braid, integral straightening vanes and flanged connection.
    - a. Flexible hose section to be 304 stainless steel, close pitch, annular corrugated hose with a type 304 braided outer covering.
    - b. End connections to be ANSI class 150 carbon steel plate flanges.
    - c. Overall length to allow for a minimum of 6" intermittent flexing.
  - 3. Connectors shall incorporate internal flow straightening vanes to reduce turbulence prior to the balancing valve. Vanes to be capable of reducing discharge turbulence equal to 5-10 pipe diameters of straight pipe, while allowing full rated movement of the connector.

## **PART 3 EXECUTION**

### **3.1 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 independent control valves in the return water line of each cooling element.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

### **3.2 HYDRONIC SPECIALTIES INSTALLATION**

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install pump suction diffusers at all suction pump connections and pump discharge flexible connections with straightening vanes to relieve pump and piping stresses and straighten flow.
- D. Install piping from boiler air separator to expansion tank with a 2 percent upward slope toward tank.
- E. Install one coalescing-type air and dirt separator per system. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
- F. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

### **3.3 TERMINAL EQUIPMENT CONNECTIONS**

- A. Provide flexible pipe connection to and from terminal, VAV or lab boxes.
- B. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- C. Install control valves in accessible locations close to connected equipment.

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- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Section 230519 "Meters and Gages for HVAC Piping."

**END OF SECTION 23 21 16**

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## **SECTION 23 25 13 WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section includes the following water treatment for closed-loop hydronic systems:
  - 1. Automatic chemical-feed equipment.
  - 2. Chemicals.

#### **1.2 DEFINITIONS**

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- B. RO: Reverse osmosis.
- C. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.
- D. MSDS: Material Safety Data Sheets.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:
  - 1. Bypass feeders.
  - 2. Water meters.
  - 3. Inhibitor injection timers.
  - 4. pH controllers.
  - 5. TSS controllers.
  - 6. Chemical solution tanks.
  - 7. Injection pumps.
  - 8. Chemical test equipment.
  - 9. Chemical MSDS.
- B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to hydronic systems.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include diagrams for power, signal, and control wiring.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Seismic Qualification Certificates: For components, from manufacturer. (Not needed if provided by SEOR)
  - 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. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.



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- C. Field quality-control reports.
- D. Other Informational Submittals:
  - 1. Water-Treatment Program: Written sequence of operation on an annual basis for the application and equipment required to achieve water quality defined in "Performance Requirements" Article.
  - 2. Water Analysis: Illustrate water quality available at Project site.

## **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

## **1.6 QUALITY ASSURANCE**

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.
- B. HVAC Water-Treatment Service Provider shall provide 10 years of documented experience if requested.

## **1.7 MAINTENANCE SERVICE**

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
  - 1. Initial water analysis and HVAC water-treatment recommendations.
  - 2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
  - 3. Periodic field service and consultation.
  - 4. Customer report charts and log sheets.
  - 5. Laboratory technical analysis.
  - 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Chem Pro.
- B. Or College Approved Equal

### **2.2 PERFORMANCE REQUIREMENTS**

- A. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.
- B. The water treatment program shall include:
  - 1. Pre-treatment clean and flush
  - 2. Passivation
  - 3. Inhibitor

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4. For remodel project where only a portion of the building is being renovate, the new supply and return piping shall be isolated from the rest of the facility, pre-treated and flushed and passivated. Once passivation is complete the new piping shall be opened to the existing facility loop to be treated with inhibitor.
  - a. Provide temporary chemical feed equipment, piping, valves tanks etc. as required to introduce cleaning, degreasing and chemicals for passivation of the piping system.
  - b. Provide temporary pump to circulate the water at a minimum of 5 feet per second.
  - c. Coordinate supply and return point of connections indicated on the plans with the mechanical contractor.
- C. Design HVAC water treatment program on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- D. Closed hydronic systems, including hot-water heating, shall have the following water qualities:
  1. pH: Maintain a value within 9.0 to 10.5.
  2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
  3. Boron: Maintain a value within 100 to 200 ppm.
  4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
  5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
  6. TSS: Maintain a maximum value of 10 ppm.
  7. Ammonia: Maintain a maximum value of 20 ppm.
  8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
  9. Microbiological Limits:
    - a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
    - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
    - c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
    - d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
    - e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

## 2.3 MANUAL CHEMICAL-FEED EQUIPMENT

- A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
  1. Capacity: 5 gal..
  2. Minimum Working Pressure: 125 psig.

## 2.4 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.
- B. All chemicals and cleaners used shall NOT contain any ammonia based chemicals, nor any phosphates or phosphorous-based chemicals.
  1. Pre-treatment Clean and Flush
    - a. Neutral pH product to maintain a pH of 7.0-8.0 in the new piping and coil system. It should not contain any ammonia or phosphate products.
    - b. Or approved equal
  2. Passivator
    - a. Condenser Water/Chilled Water
      - 1) pH 8.5 to 10.5

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- 2) Nitrite at 1,000-1200 ppm
- 3) Molybdate at 400 ppm +/- 100-120 ppm
- 4) Azole at 40 ppm +/- 10-20 ppm
- 5) Or approved equal
- b. Hot Water
  - 1) pH 8.5 to 10.5
  - 2) Sodium Nitrite 1,000-1200ppm
  - 3) Azole at 40 ppm +/- 10-20 ppm
  - 4) Or approved equal
- 3. Inhibitor
  - a. Nitrite based closed circuit corrosion and scale inhibitor

C. If tied into a TES system, use molybdenum based closed circuit corrosion and scale inhibitor

## **PART 3 EXECUTION**

### **3.1 GENERAL**

- A. Prior to any chemical water treatment or passivation measures, contact College to confirm facility requirements for passivation. Any specific Owner requirements and instructions for passivation measures shall supersede this specification section.
- B. If the system is hydrotested before being cleaned and passivated, the hydrotest water shall be city water or its equivalent, and the system and/or coils shall not remain filled and stagnant for more than seven (3) days prior to cleaning and passivation.

### **3.2 WATER ANALYSIS**

- A. Perform an analysis of supply water to determine quality of water available at Project site.
- B. Water samples taken during each step shall be analyzed, at least, for the pH, conductivity, copper, iron, total alkalinity, phosphate, total hardness, and chlorides. Additional tests shall be taken as noted in this procedure.

### **3.3 PREPARATION**

- A. Hydronic piping test for leaks and defects shall be completed prior to the HVAC water treatment is to begin. If testing is performed in segments, submit separate pressure test report for each segment, complete with diagram of portion of piping tested.
- B. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.

### **3.4 INSTALLATION**

- A. Install in accordance with the HVAC Water Treatment Providers recommendations.
  - 1. Temporary Circulation Pumps
    - a. Coordinate with the Mechanical Contractor the configuration of any temporary pumps, chemical feed equipment, valves and piping for the chemical cleaning and passivation.
    - b. Provide pumps, piping connections and shut-off valves between HVAC water-treatment equipment and the piping to allow for the circulation of the water treatment at minimum of 5 FPS velocities.
    - c. Provide backflow preventers as required for temporary makeup-water fill connections to potable-water systems.

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- d. The temporary system shall be operational, filled, started and vented prior to cleaning.
  - e. Mechanical Contractor shall coordinate with the University's representative and the University's existing HVAC Water-Treatment Service Provider to schedule the water treatment and final fill requirements.
- B. Install chemical treatment equipment on 4" thick minimum concrete housekeeping pads, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. (ref 033000 Cast In Place Concrete)
- C. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Provide general-duty ball valves as specified in Section 230523.(or 230523.12 Ball Valves) Provide threaded connection on the inlet and outlet with plugs
- D. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- E. Install water testing equipment on wall near water chemical application equipment.
- F. Install interconnecting control wiring for chemical treatment controls and sensors.
- G. Mount sensors and injectors in piping circuits. Coordinate with mechanical contractor.
- H. Coordinate with electrical contractor for power to chemical treatment pumps and equipment.
- I. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, and equipped with the following:
- 1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
  - 2. Install water meter in makeup-water supply.
  - 3. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
  - 4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
  - 5. Install a swing check on the inlet after the isolation valve.

### 3.5 CONNECTIONS

- A. Where installing piping adjacent to equipment, allow space for service and maintenance.
- B. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232116 "Hydronic Piping Specialties."
- C. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523 "General Duty Valves for HVAC Piping"

### 3.6 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.

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- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
  - 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
  - 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
  - 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
  - 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
  - 7. 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 test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
  - 8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- C. Equipment will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. At four-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to "Performance Requirements" Article.
- F. Comply with ASTM D 3370 and with the following standards:
  - 1. Silica: ASTM D 859.
  - 2. Acidity and Alkalinity: ASTM D 1067.
  - 3. Iron: ASTM D 1068.
  - 4. Water Hardness: ASTM D 1126.

### 3.7 WATER TREATMENT SEQUENCE

- A. Pre-Treatment and Flush
  - 1. This step should be done within 24 hour of the disinfection procedure.
  - 2. Isolate existing piping from new piping so as to circulate solution in the newly installed pipe system ONLY.
  - 3. Contractor shall provide valves and piping as necessary to bypass the existing water systems.
  - 4. Add sufficient neutral-based cleaner, as recommended by the manufacturer, to the system and/or coils water, and circulate for 24-36 hours at full flow.
  - 5. Drain and refill and flush the system with city water for at least one (1) hour or until the rinse water is clean of any particulates or oil. Continue the flushing procedure until the water is equivalent to city water.
  - 6. At the end of the cleaning, take and analyze water samples as noted in the notes section above.
- B. Passivation
  - 1. Start passivation at the end of the cleaning cycle, no longer than six (6) hours later.

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2. Add the passivation chemical to the system and circulate for six (6) hours, but test after two (2) hours for nitrate or molybdate and azole levels to ensure the required levels are reached, as shown in the notes section above. If the levels are below the required levels, then add additional chemicals and retest in another two (2) hours. Repeat until the proper levels are reached. Once the proper levels are reached, circulate for six (6) hours.
  3. At the end of passivation, take and test water samples for the nitrate or molybdate and azole levels.
  4. Once approved, the new system and/or coils may be tied into the campus TES chilled water and/or heating hot water system.
- C. Inhibitor
1. Start inhibitors at the end of the cleaning cycle, no longer than six (6) hours later.
  2. Add the inhibitors chemical to the system and circulate for six (6) hours, but test after two (2) hours inhibitor levels. If the levels are below the required levels, then add additional chemicals and retest in another two (2) hours. Repeat until the proper levels are reached.
  3. After adding inhibitor, take and test water samples for the nitrate or molybdate and azole levels.
- D. Once approved, the new system and/or coils may be tied into the campus chilled water and/or heating hot water system.

**END OF SECTION 23 05 13**

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## 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 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
  - 2. Section 233300 "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.

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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.



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## **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

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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.
  - 2. 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.
  - 3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

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- 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.

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- 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.

## 2.5 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.

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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.

## 2.6 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.

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2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## **2.7 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**

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## **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.

NFPA 90A	Installation of Air Conditioning and Ventilating Systems.
SMACNA	Low Pressure Duct Construction Standards.
UL 33	Heat Responsive Links for Fire-Protection Service.
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.
1. 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:
    - a. Special fittings.
    - b. Manual volume damper installations.
    - c. Combination fire- and smoke-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
    - d. 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



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covering for storage and identified with labels describing contents.

- B. Fusible Links: Furnish quantity equal to 10 percent of amount installed

## **PART 2 GENERAL**

### **2.0 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.

### **2.1 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.

### **2.2 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.



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- 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.

## **2.3 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.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Compliance with ASHRAE/IESNA 90.1-2004 includes Section 6.4.3.3.3 - "Shutoff Damper Controls," restricts the use of backdraft dampers, and requires control dampers for certain applications. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. To minimize duct noise generated by volume dampers, SMACNA recommends locating dampers at least two duct diameters from fittings and as far away as possible from outlets.
- E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
  - 1. Coordinate subparagraphs below with Section 233113 "Metal Ducts."
  - 2. Install steel volume dampers in steel ducts.
  - 3. Install aluminum volume dampers in aluminum ducts.
- F. Set dampers to fully open position before testing, adjusting, and balancing.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated.

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- H. Install fire and smoke dampers according to UL listing.
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. On both sides of duct coils.
  - 2. Upstream from duct filters.
  - 3. At outdoor-air intakes and mixed-air plenums.
  - 4. At drain pans and seals.
  - 5. Downstream from backdraft dampers.
  - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links.  
Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
  - 7. At each change in direction and at maximum 50-foot spacing.
  - 8. Upstream from turning vanes.
  - 9. Control devices requiring inspection.
- J. Install access doors with swing against duct static pressure.
- K. Access Door Sizes:
  - 1. One-Hand or Inspection Access: 8 by 5 inches
  - 2. Two-Hand Access: 12 by 6 inches
  - 3. Head and Hand Access: 18 by 10 inches
  - 4. Head and Shoulders Access: 21 by 14 inches
  - 5. Body Access: 25 by 14 inches
  - 6. Body plus Ladder Access: 25 by 17 inches
- L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- M. Install flexible connectors to connect ducts to equipment.
- N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- O. Where indicated on Drawings, connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- P. Connect flexible ducts to metal ducts with draw bands.
- Q. Install duct test holes where required for testing and balancing purposes.
- R. Retain paragraph below for thrust limits on flexible connections for fans.
- S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

### 3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Operate dampers to verify full range of movement.
  - 2. Inspect locations of access doors and verify that purpose of access door can be

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performed.

3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

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## **SECTION 23 37 13 DIFFUSERS, REGISTERS, AND GRILLES**

### **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. Modular core supply grilles.
  - 2. Fixed face registers and grilles.
- B. Related Sections:
  - 1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
  - 2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated, include the following:
  - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
  - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. 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. Revise subparagraphs below to suit Project.
  - 2. Ceiling suspension assembly members.
  - 3. Method of attaching hangers to building structure.
  - 4. Size and location of initial access modules for acoustical tile.
  - 5. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
  - 6. Duct access panels.
- C. Source quality-control reports.

### **PART 2 PRODUCTS**

#### **2.1 CEILING DIFFUSERS**

- A. Modular Core Supply Grilles:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on drawings or a comparable product by one of the following:
    - a. Krueger.
    - b. Price Industries.
    - c. Titus.

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3. Throw: Extended distance for airflow rates.
4. Material: Steel.
5. Grilles per Unit: Four.
6. Finish: White baked acrylic.
7. Border: 1-1/2-inch (38-mm) width with countersunk screw holes. And 24x24 filler panel.
8. Blades:
  - a. Set in modules.
9. Modules: Removable; rotatable.
10. Mounting: Surface and lay-in tee bar.
11. Accessory: Opposed-blade steel damper.

## 2.2 REGISTERS AND GRILLES

- A. Fixed Face Register:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on drawings or a comparable product by one of the following:
    - a. Krueger.
    - b. Price Industries.
    - c. Titus.
  3. Material: Steel or Aluminum.
  4. Finish: Baked enamel, white.
  5. Face Blade Arrangement: Horizontal spaced 3/4 inch (19 mm) apart.
  6. Core Construction: Integral.
  7. Frame: 1 inch (25 mm) wide.
  8. Mounting: Countersunk screw.
  9. Damper Type: Adjustable opposed blade.

## 2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

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- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

### **3.3 ADJUSTING**

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

**END OF SECTION 23 37 13**

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## **SECTION 23 65 14.16 CLOSED-CIRCUIT, INDUCED-DRAFT, COUNTERFLOW COOLING TOWERS**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section includes factory-assembled, closed-circuit, induced-draft, counterflow cooling towers.

#### **1.2 DEFINITIONS**

- A. SCCR: Short-circuit current rating.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
1. Include rated capacities, pressure drop, fan performance data, rating at selected points indicated, and furnished specialties and accessories.
  2. Maximum flow rate.
  3. Minimum flow rate.
  4. Pressure required at cooling tower supply piping connections.
  5. Pressure required at collection basin sweeper supply piping connections.
  6. Drift loss as percent of design flow rate.
  7. Volume of water in suspension for purposes of sizing remote storage.
  8. Sound:
    - a. Sound pressure levels for operation with fan off, fan at minimum speed, and design speed. If sound requirements are indicated at a specific distance, submit performance using same distance for comparative analysis.
    - b. Sound power levels in eight octave bands for operation with fans off, fans at minimum speed, and design speed.
  9. Fan airflow at design conditions, brake horsepower, and drive losses (indicated in horsepower and percent of brake horsepower).
  10. Fan motor electrical characteristics including, but not limited to, speed, voltage, phase, hertz, amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
  11. Pump flow rate, head, brake horsepower, and efficiency.
  12. Pump motor electrical characteristics including, but not limited to, speed, voltage, phase hertz, amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
  13. Electrical power requirements for each cooling tower component requiring power.
- B. Shop Drawings:
1. Manufacturer's drawings of assembled cooling towers, control panels, sections, and elevations.
  2. Assembled unit dimensions.
  3. Diagram showing each separate piece requiring field assembly.
  4. Shipped sub-assembly dimensions and weights for field assembly.
  5. Assembled unit weight without water.
  6. Operating weight and load distribution.
  7. Unit vibration isolation and seismic controls.
  8. Required clearances for maintenance and operation.
  9. Sizes and dimensioned locations of piping and wiring connections.

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10. Diagrams for power, signal, and control wiring.
- C. Delegated-Design Submittal: For cooling tower support structure 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 support structure.
  2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
  3. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
  1. Drawings on which the following items are shown and coordinated with each other, using input from installers of the items involved:
    - a. Structural supports.
    - b. Piping roughing-in requirements.
    - c. Conduit and wiring roughing-in requirements for controls and electrical power, including spaces reserved for controls and electrical equipment.
    - d. Access requirements, including working clearances for controls and electrical equipment, and service clearances. Mark and label clearances.
  2. Drawings showing plans, sections, and elevation views, drawn to scale of at least  $\frac{1}{4}" = 1'-0"$ .
  3. Each view to show screened background with the following:
    - a. Structural grids.
    - b. Adjacent walls, floors, and roofs.
    - c. Equipment and products of other trades that are located in vicinity of cooling towers and are part of final installation, such as controls, power, lighting, fire-suppression systems, and plumbing systems.
- B. Seismic Qualification Data: Certificates, for cooling towers, 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. Product Certificates: For certification required in "Quality Assurance" Article.
- D. Field Test Reports: Include startup service reports.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample Warranty: For special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each cooling tower to include in emergency, operation,

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and maintenance manuals.

- B. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

## **1.6 MAINTENANCE MATERIAL SUBMITTALS**

- A. Belts:
  - 1. Furnish one set(s) of matching belts for each unique belt configuration and size furnished.
- B. Touchup Coating: 32-oz. container of paint coating used. Label outside of container with detailed description of coating to allow for procurement of a matching coating in the future.

## **1.7 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Certified by CTI.
- B. ASME Compliance: Fabricate and label heat-exchanger coils to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- C. CTI Certification: Cooling tower thermal performance according to CTI STD 201RS.
- D. FM Global: Approval and listing in the latest edition of FM Global's "Approval Guide."

## **1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Coordinate requirements for multi-piece assembly for shipment. Limit the number of separate pieces for field installation to as few as possible.
- B. If factory assembly of multiple pieces is required for testing or other reasons, disassemble cooling tower into major assemblies as required by installation before packaging for shipment.
  - 1. Clearly label each separate package with a unique designation and include with assembly instructions for each complete cooling tower.
  - 2. Install seals on gear-drive assemblies to eliminate oil leakage during shipment if shipped with oil.

## **1.9 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:
  - 1. All components of cooling tower.
  - 2. Fan assembly including fan, drive, and motor.
  - 3. Warranty Period: Five years from date of Substantial Completion.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

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- A. BAC
- B. Recold
- C. Approved Equal.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cooling tower support structure and seismic restraints, including comprehensive engineering analysis.
- B. Structural Performance: Cooling tower and support structure shall withstand the effects of loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
- C. Seismic Performance: Cooling towers 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."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.
- E. 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.
- F. Vibration:
  - 1. Rotating assemblies shall be dynamically balanced to achieve a balance level of "good" while complying with industry standard requirements for cooling towers.
  - 2. Critical speed shall be at least 115 percent of design speed.

## 2.3 DESIGN ARRANGEMENT

- A. Counterflow design with airflow from all sides and induced-draft, top-mounted axial fan and pressurized pipe distribution.

## 2.4 CASING AND FRAME

- A. Casing Material: Stainless steel, Grade 300.
- B. Frame Material: Stainless steel, Grade 300.
- C. Hardware: Stainless steel.
- D. Joints and Seams: Sealed watertight.
- E. Welded Connections: Sealed watertight by continuous welds.

## 2.5 COLLECTION BASIN

- A. Factory-Assembled Collection Basin:
  - 1. Material: Stainless steel, Grade 300.

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2. Hardware: Stainless steel.
3. Joints and Seams: Sealed watertight.
4. Welded Connections: Sealed watertight by continuous welds.
5. Removable stainless-steel strainer with openings smaller than nozzle orifices.
6. Overflow and drain connections.
7. Makeup-water connection.
8. Outlet Connection: Configured to mate to ASME B16.5, Class 150 flange.
9. Basin Sweeper Distribution Piping and Nozzles:
  - a. Pipe Material: PVC, Schedule 40 or heavier, treated with UV inhibitors and intended for continuous exposure to direct sunlight with degradation.
  - b. Nozzle Material: Plastic.
  - c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.
  - d. Basin penetrations sealed watertight.
  - e. Field Connections: Threaded or flanged depending on pipe size.

## 2.6 COLLECTION BASIN MAKEUP-WATER ASSEMBLY

- A. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.
- B. Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve:
  1. Enclosures: NEMA 250, Type 4.
  2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to control makeup-water valve.
  3. Electrode Probes: Stainless steel.
  4. Makeup-Water Valve:
    - a. Slow closing with stainless-steel body.
    - b. Valve actuator controlled and powered through level controller in response to water-level set point.
    - c. Actuator Enclosure: NEMA 250, Type 4.
    - d. Fail Position: Last.
    - e. Action: Two position.
  5. Electrical Connection Requirements: 120-V ac, single phase, 60 Hz.

## 2.7 PRESSURIZED DISTRIBUTION NETWORK

- A. Main header and lateral branch piping designed for even distribution over heat-exchanger coils throughout the entire flow range without the need for balancing valves and for connecting individual, easily removable, nonclogging spray nozzles.
- B. Pipe Material: Schedule 40 PVC.
- C. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

## 2.8 HEAT-EXCHANGER COILS

- A. Tube and Tube Sheet Materials: Copper tube with stainless-steel tube sheet with copper headers.
- B. Heat-Exchanger Arrangement:

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1. Serpentine tubes; sloped for complete drainage of fluid by gravity.
  2. Tubes with extended surface fins if required to achieve performance indicated.
  3. Multiple Separate Circuits: Separate circuits to achieve multiple isolated loops as required by application.
- C. ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and bearing ASME "U" stamp; sloped for complete drainage of fluid by gravity.
- D. Field Piping Connections: Vent, supply, and return suitable for mating to ASME B16.5, Class 150 flange.

## 2.9 DRIFT ELIMINATORS

- A. Material: PVC; with maximum flame-spread index of 25 according to ASTM E84.
- B. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
- C. Arrangement: Multiple, easily removable sections.
- D. Configuration: Multipass, designed and tested to reduce water carryover to 0.001 percent of design flow rate indicated.
- E. Hardware: Stainless steel.

## 2.10 AIR INLET

- A. Air-Intake Louvers:
1. Material: PVC.
  2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
  3. Multiple, easily removable sections arranged to uniformly direct air into cooling tower, to minimize air resistance, to block direct sunlight, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.
- B. Hardware: Stainless steel.

## 2.11 FAN AND DRIVE ASSEMBLY

- A. Axial Fan: Balanced at the factory after assembly.
1. Blade Material: Aluminum or galvanized steel.
  2. Hub Material: Aluminum or galvanized steel.
  3. Blade Pitch: Field adjustable.
  4. Fan Shaft: Corrosion resistant.
  5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of 100,000 hours.
  6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
  7. Automatic Bearing Greasing System:
    - a. Manufacturer designed system to provide an as needed supply of new grease to bearings while reducing the need for periodic bearing maintenance and associated greasing problems.
    - b. Easily replaceable storage container filled with recommended grease and located

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in an easily accessible location on cooling tower exterior. Container capacity of sufficient size to provide grease for one year.

- B. Belt Drive:
  - 1. Service Factor: 1.5 based on motor nameplate horsepower.
  - 2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
  - 3. Belt: One-piece, multigrooved, solid-back belt.
  - 4. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
  - 5. Belt-Drive Guard: Comply with OSHA regulations.
- C. Fan Motor:
  - 1. Comply with NEMA MG 1 unless otherwise indicated.
  - 2. Description: NEMA MG 1, Design B, as required to comply with capacity and torque characteristics; medium induction motor.
  - 3. 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.
  - 4. Motor Enclosure: Open dripproof with weather protective cover.
  - 5. Rotor: Random-wound, squirrel cage.
  - 6. Energy Efficiency: NEMA Premium Efficient.
  - 7. Service Factor: 1.15.
  - 8. Temperature Rise: Match insulation rating.
  - 9. Insulation: Class F.
  - 10. Variable-Speed Motors: Inverter-duty rated per NEMA MG 1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
  - 11. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
  - 12. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.
  - 13. Motor Shaft Grounding: Motors shall be controlled through variable-frequency controllers with shaft grounding system to protect motor bearings from induced voltage. Drag on motor shaft due to shaft ground system shall be less than 0.5 percent of motor nameplate horsepower.
- D. Hardware: Galvanized or stainless steel.

## 2.12 AIR DISCHARGE

- A. Fan Discharge Stack:
  - 1. Manufacturer's standard low-profile design.
  - 2. Stack Extension: Fabricated to extend above fan deck as noted on plans.
  - 3. Stack Termination: Wire-mesh, stainless-steel screens; segmented into multiple removable pie sections and complying with OSHA regulations.
    - a. If not provided with factory controls, field-connect provisions for electrical power and controls to open dampers when pump is energized and close dampers when pump is de-energized.

## 2.13 RECIRCULATING WATER DISTRIBUTION SYSTEM

- A. Pump: Close-coupled, single-stage, bronze-fitted centrifugal pump; with mechanical seal and

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suitable for outdoor service. Factory install pump with following:

1. Redundant Pump: Same performance as required for primary pump; easily switched and maintained while cooling tower remains operating.
2. Flanges at pump connections to piping.
3. Strainer, with blowdown isolation valve, installed in piping on suction side of pump.
4. Flow balancing valve in piping on discharge side of pump.

**B. Pump Motor:**

1. Comply with NEMA MG 1 unless otherwise indicated.
2. Description: NEMA MG 1, Design B, as required to comply with capacity and torque characteristics; medium induction motor.
3. 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.
4. Motor Enclosure: Open dripproof.
5. Rotor: Random-wound, squirrel cage.
6. Energy Efficiency: NEMA Premium Efficient.
7. Service Factor: 1.15.
8. Temperature Rise: Match insulation rating.
9. Insulation: Class F.

## **2.14 ELECTRICAL POWER**

- A. Factory Install: A variable-frequency controller for each fan motor and a motor controller for each pump motor.
  1. Locate in a convenient and field-accessible location within sight of motor.
  2. Installation shall comply with NFPA 70.
- B. Variable-Frequency Controllers: Provide per specification 230514 "Variable Frequency Drives."

## **2.15 WATER TREATMENT**

- A. Chemical Water Treatment System: Complete factory-installed system consisting of the following:
  1. Microprocessor-controlled conductivity controller housed in NEMA 250, Type 4X enclosure.
  2. Chemical metering pump housed in NEMA 250, Type 4X enclosure.
  3. Electrically operated valve designed to control totally dissolved solids levels and bleed rates.
  4. Piping associated with system.
  5. Interconnecting power and control wiring installed in corrosion-resistant metal raceway.

## **2.16 SERVICE ACCESS**

- A. Doors:
  1. Large enough for personnel to access cooling tower internal components.
  2. Doors shall be hinged with handles operable from both sides of the door.
  3. Door materials shall match casing.
  4. Hinges and handles shall be [corrosion resistant] [stainless steel] <Insert material>.

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## 2.17 SOURCE QUALITY CONTROL

- A. Performance Test: Factory test and certify cooling tower performance according to CTI STD 201RS, "Standard for the Certification of Water-Cooling Tower Thermal Performance."
  - 1. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.
- B. Factory Functional Tests:
  - 1. Test collection and distribution basins after assembly, and prove free of leaks.
  - 2. Test factory-installed electric/electronic water-level controls for proper operation.
  - 3. Test factory-installed electric basin heaters for proper operation.
  - 4. Test factory-installed fan and drive assemblies for proper operation.
  - 5. Test factory-installed control package for proper operation.
  - 6. Test access doors to ensure smooth operation and proper fit.
  - 7. Submit report documenting tests performed and results within one week of test date.
- C. Heat-Exchanger Factory Pressure and Leak Tests:
  - 1. Pneumatically test heat-exchanger assembly while submerged underwater and prove to be free of leaks.
  - 2. Submit report documenting test and results.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine cooling towers before installation. Reject cooling towers that are damaged.
- B. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting cooling tower performance, maintenance, and operation.
  - 1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.
  - 2. Verify sizes and locations of concrete bases and support structure with actual equipment.
  - 3. Verify sizes, locations, and anchoring attachments of structural-steel support structures.
  - 4. Verify sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install cooling towers on support structure.
- B. Equipment Mounting:
  - 1. Install cooling towers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
  - 2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
  - 3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

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- C. Install anchor bolts to elevations required for proper attachment to supported equipment.
- D. Maintain manufacturer's recommended clearances for service and maintenance.
- E. Maintain clearances required by governing code.
- F. Loose Components: Install components, devices, and accessories furnished by manufacturer with cooling tower, that are not factory mounted.
  - 1. Loose components shall be installed by Contractor under supervision of manufacturer's factory-trained service personnel.

### 3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to cooling towers, allow space for service and maintenance.
- C. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.
- D. Install drain piping with valve at cooling tower drain connections and at low points in piping.
- E. Connect cooling tower overflows and drains, and piping drains to sanitary sewage system.
- F. Makeup-Water Piping:
  - 1. Comply with applicable requirements in Section 221116 "Domestic Water Piping."
  - 2. Connect to makeup-water connections with shutoff valve, plugged tee with pressure gage, and drain connection with valve and union.
- G. Supply and Return Piping:
  - 1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
  - 2. Connect to entering cooling tower connections with shutoff valve, strainer, balancing valve, thermometer, plugged tee with pressure gage, and drain connection with valve.
  - 3. Connect to leaving cooling tower connection with shutoff valve thermometer, plugged tee with full port ball valve for portable field instruments, and drain connection with valve.
  - 4. Make connections to cooling tower with a flange.
- H. Basin Sweeper Piping:
  - 1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
  - 2. Connect to supply connections with shutoff valve and drain connection with valve.
  - 3. Connect to return connections with shutoff valve, balancing valve, and drain connection with valve.
  - 4. Make connections with a flange or union.

### 3.4 ELECTRICAL POWER CONNECTIONS

- A. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.
- B. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and

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Cables" for wiring connections.

- C. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.
- D. Install nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

### 3.5 CONTROLS CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between cooling towers and other equipment to interlock operation as required to achieve a complete and functioning system.
- C. Connect control wiring between cooling tower control interface and DDC system for remote monitoring and control of cooling towers. Comply with requirements in Division 25.
- D. Install label at each termination indicating control equipment designation serving cooling tower and the I/O point designation for each control connection. Comply with requirements in Section 260553 "Identification for Electrical Systems" for labeling and identification products and installations.

### 3.6 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 tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections: Comply with CTI ATC 105.
- D. Cooling towers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping; controls; and electrical connections for proper assemblies, installations, and connections.
- C. Obtain performance data from manufacturer.
  - 1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
    - a. Clean entire unit including basins.
    - b. Verify that accessories are properly installed.
    - c. Verify clearances for airflow and for cooling tower servicing.

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- d. Check for vibration isolation and structural support.
  - e. Lubricate bearings.
  - f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
  - g. Verify pump rotation for correct direction, vibration, cavitation, and flow and correct problems.
  - h. Adjust belts to proper alignment and tension.
  - i. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
  - j. Check vibration switch setting. Verify operation.
  - k. Verify water level in tower basin. Fill to proper startup level. Check makeup-water-level control and valve.
  - l. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
  - m. Replace defective and malfunctioning units.
- D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.
- E. Prepare a written startup report that records the results of tests and inspections.

### 3.8 ADJUSTING

- A. Set and balance water flow to each tower inlet.
- B. Adjust water-level control for proper operating level.
- C. Adjust basin heater control for proper operating set point.

### 3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cooling towers.
  - 1. Video record the training sessions.
  - 2. Instructor shall be factory trained and certified.
  - 3. Perform not less than 8 hours of training.
  - 4. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
  - 5. Perform instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
  - 6. Obtain Owner sign-off that training is complete.
  - 7. Owner training shall be held at Project site.

**END OF SECTION 23 65 14.16**

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## **SECTION 238146 WATER-SOURCE UNITARY HEAT PUMPS**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section includes unitary heat pumps with refrigerant-to-water heat exchangers, refrigeration circuits, and refrigerant compressor(s).

#### **1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each water-source unitary heat pump.
- C. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- D. Shop Drawings:
- E. Include plans, elevations, sections, and mounting and attachment details.
- F. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- G. Include diagrams for power, signal, and control wiring.

#### **1.3 INFORMATIONAL SUBMITTALS**

- A. Seismic Qualification Certificates: For water-source unitary heat pumps, accessories, and components, from manufacturer.
- B. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
- C. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Product Certificates: For each type of water-source unitary heat pump, signed by product manufacturer.
- F. Field quality-control reports.
- G. Sample Warranty: For manufacturer's warranty.

#### **1.4 CLOSEOUT SUBMITTALS**

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- A. Operation and Maintenance Data: For water-source unitary heat pumps to include in emergency, operation, and maintenance manuals.

## **1.5 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace components of water-source unitary heat pumps that fail in materials or workmanship within specified warranty period.
- B. Failures include, but are not limited to, refrigeration components.
- C. Warranty Period: Four years from date of Substantial Completion.

## **PART 2 PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. ASHRAE Compliance:
- B. ASHRAE 15.
- C. Comply with NFPA 70.
- D. Comply with safety requirements in UL 484 for assembly of free-delivery, water-source heat pumps.

### **2.2 WATER-SOURCE UNITARY HEAT PUMPS, 6 TONS AND SMALLER**

- A. Manufacturer's: Climatemaster, Trane, or approved equal.
- B. Description: Packaged water-source unitary heat pump with temperature controls; factory assembled, piped, wired, tested, and rated according to ASHRAE/ARI/ISO-13256-1.
- 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.
- D. Cabinet and Chassis: Galvanized-steel casing with the following features:
- E. Access panel for access and maintenance of internal components.
- F. Knockouts for electrical and piping connections.
- G. Cabinet Insulation: Glass-fiber liner, minimum 1/2-inch-thick, complying with UL 181, ASTM C1071, and ASTM G21.
- H. Water Circuits:
- I. Refrigerant-to-Water Heat Exchangers:
  - 1. All units shall contain an HFC-410A sealed refrigerant circuit including a high efficiency scroll or rotary compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, an enhanced corrugated aluminum lanced fin and rifled copper tube refrigerant to air heat exchanger, reversing valve, coaxial (tube in

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tube) refrigerant to water heat exchanger, and safety controls including a high pressure switch, low pressure (loss of charge) switch, water coil low temperature sensor, and air coil low temperature sensor. Access fittings shall be factory installed on high- and low-pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit. The lockout circuit shall be reset at the thermostat or at the contractor supplied disconnect switch. ***Units that cannot be reset at the thermostat shall not be acceptable.***

2. The compressor shall have a dual level vibration isolation system. The compressor will be mounted on specially engineered sound-tested EPDM vibration isolation grommets or springs to a large heavy gauge compressor mounting plate, which is then isolated from the cabinet base with rubber grommets for maximized vibration attenuation. Compressor shall have thermal overload protection. Compressor shall be located in an insulated compartment away from air stream to minimize sound transmission.
  3. Refrigerant to air heat exchangers shall utilize enhanced corrugated lanced aluminum fins and rifled copper tube construction rated to withstand 625 PSIG (4309 kPa) refrigerant working pressure. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 625 PSIG (4309 kPa) working refrigerant pressure and 500 PSIG (3445 kPa) working water pressure. The refrigerant to water heat exchanger shall be "electro-coated" with a low cure cathodic epoxy material a minimum of 0.4 mils thick (0.4 – 1.5 mils range) on all surfaces. The black colored coating shall provide a minimum of 1000 hours salt spray protection per ASTM B117-97 on all external steel and copper tubing. The material shall be formulated without the inclusion of any heavy metals and shall exhibit a pencil hardness of 2H (ASTM D3363-92A), crosshatch adhesion of 4B-5B (ASTM D3359-95), and impact resistance of 160 in-lbs (184 kg-cm) direct (ASTM D2794-93).
- J. Filter-Dryer: Factory installed to clean and dehydrate the refrigerant circuit.
- K. Charging Connections: Service fittings on suction and liquid for charging and testing on each circuit.
- L. Reversing Valve: Four-way, solenoid-activated valve designed to be fail-safe in heating position with replaceable magnetic coil.
- M. Compressor:
1. Scroll.
  2. Installed on vibration isolators and mounted on a structural steel base plate and full-length channel stiffeners.
  3. Exterior of compressor shall be wrapped with a high-density sound-attenuating blanket and housed in an acoustically treated enclosure.
  4. Factory-Installed Safeties:
  5. Antirecycle timer.
  6. High-pressure cutout.
  7. Low-pressure cutout or loss of charge switch.
  8. Internal thermal-overload protection.
  9. Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below 35 deg F.
- N. Water-coil, low-temperature switch.
- O. Refrigerant Piping Materials: ASTM B743 copper tube with wrought-copper fittings and brazed joints.
- P. Pipe Insulation: Refrigerant minimum 3/8-inch- thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-developed indexes

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according to ASTM E84.

- Q. Refrigerant Metering Device: Thermal-expansion valve.
- R. Controls: Control equipment and sequence of operation are specified in Division 25
- S. Controls:
  - 1. Basic Unit Control Modes and Devices:
  - 2. Unit shutdown on high or low refrigerant pressures.
  - 3. Unit shutdown on low water temperature.
  - 4. Low- and high-voltage protection.
  - 5. Overcurrent protection for compressor.
  - 6. Random time delay, three to 10 seconds, start on power-up.
  - 7. Time delay override for servicing.
  - 8. Control voltage transformer.
  - 9. Water-coil freeze protection (selectable for water or antifreeze).
  - 10. Automatic intelligent reset. Unit shall automatically reset five minutes after trip if the fault has cleared. Should a fault reoccur three times sequentially, lockout requiring manual reset occurs.
  - 11. Ability to defeat time delays for servicing.
  - 12. Digital display to indicate high pressure, low pressure, low voltage, and high voltage.
  - 13. The low-pressure switch shall not be monitored for the first 90 seconds after a compressor start command to prevent nuisance safety trips.
  - 14. Remote fault-type indication at thermostat.
  - 15. Selectable 24-V dc or pilot duty dry contact alarm output.
  - 16. 24-V dc output to cycle a motorized water valve with compressor contactor.
  - 17. Service test mode for troubleshooting and service.
  - 18. Unit-performance sentinel warns when heat pump is running inefficiently.
  - 19. Compressor soft start.
- T. Thermostat:
  - 1. Wall-Mounted Thermostat:
  - 2. Deg F indication.
  - 3. Wall-mounted temperature sensor.
  - 4. Duct-mounted temperature sensor
  - 5. Unoccupied period override push button.
  - 6. Digital display to indicate fault condition at heat pump.
  - 7. Data entry and access port.
  - 8. Input data include room temperature and humidity set points for occupied and unoccupied periods.
  - 9. Output data include room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.
- U. Terminal Controller:
  - 1. Scheduled operation for occupied and unoccupied periods on seven-day clock with minimum of four programmable periods per day.
  - 2. Two-hour unoccupied override period.
  - 3. Remote-control panel to contain programmable timer and digital display for fault condition.
  - 4. Compressor-disable relay to stop compressor operation for demand limiting or switch to unoccupied operation.
  - 5. Automatic restart after five minutes if fault clears. Lockout after three attempts to restart following fault. Indicate fault for service technician.
  - 6. Backup for volatile memory.
  - 7. DDC interface requirements as further described in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC"

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DDC."

8. Interface relay for scheduled operation.
  9. Interface relay to provide indication of fault at central workstation.
  10. Provide BAC-net interface for central DDC workstation for the following functions:
  11. Set-point adjustment.
  12. Start/stop and operating status of heat-pump unit.
  13. Data inquiry to include supply-air and room-air temperature and humidity and entering-water temperature.
  14. Occupied and unoccupied schedules.
- V. Electrical Connection: Single electrical connection with fused disconnect.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electric installations for water-source unitary heat pumps to verify actual locations of piping connections and electrical conduits before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Equipment Mounting:
  1. Install water-source, unitary heat pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
  2. Comply with requirements for vibration-isolation and seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
  3. Comply with requirements for vibration-isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
  4. Suspend water-source, unitary heat pumps from structure with all-thread hanger rods and spring hangers with vertical-limit stop. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
  5. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls or as required in Section 230923 "Direct Digital Control (DDC) System for HVAC."
- B. CONNECTIONS
  1. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
  2. Connect supply and return hydronic piping to heat pump with hose kits.
  3. Install electrical devices furnished by manufacturer but not specified to be factory mounted.
  4. Install piping adjacent to machine to allow space for service and maintenance.

### **3.3 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and



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inspect components, assemblies, and equipment installations, including connections.

- B. Perform the following field tests and inspections:
  - 1. After installing water to water heat pumps and after electrical circuitry has been energized, test units for compliance with requirements.
  - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
  - 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. Heat pumps will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

### **3.4 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions.
- C. Inspect for visible damage to unit casing.
- D. Inspect for visible damage to compressor and coils.
- E. Inspect internal insulation.
- F. Verify that labels are clearly visible.
- G. Verify that clearances have been provided for servicing.
- H. Verify that controls are connected and operable.
- I. Adjust vibration isolators.
- J. Start unit according to manufacturer's written instructions.
- K. Complete startup sheets and attach copy with Contractor's startup report.
- L. Record superheat and subcooling during start-up.
- M. Inspect and record performance of interlocks and protective devices; verify sequences.
- N. Operate unit for an initial period as recommended or required by manufacturer.
- O. Verify thermostat calibration.
- P. Inspect controls for correct sequencing of heating, refrigeration, and normal and emergency shutdown.

### **3.5 ADJUSTING**

- A. Adjust initial temperature set points.

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- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to **two** visits to Project during other-than-normal occupancy hours for this purpose.

### **3.6 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water-source unitary heat pumps.

**END OF SECTION 23 81 46**

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**SECTION 25 00 00**  
**INTEGRATED AUTOMATION SYSTEMS (IAS) FOR HVAC**

**PART 1 - GENERAL**

**1.1 RELATED SPECIFICATIONS:**

- A. Section 250600 - Network Scheduling Software for HVAC
- B. Section 250800 – Fault Detection and Diagnostics Software for HVAC
- C. Section 251400 – IAS Network Controllers for HVAC
- D. Section 251500 – IAS Software and Programming Tools for HVAC
- E. Section 259500 – Integrated Automation Control Sequences for HVAC

**1.2 SUMMARY**

- A. This section describes the Systems Integration scope of work for the project.
- B. All labor, material, equipment and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, shall be provided without additional cost to the Owner.
- C. It is the owner's goal to implement an Open Protocol that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s).
- D. This section Includes:
  - 1. Project Specific Scope of Work
  - 2. General IAS Installation Scope of Work
  - 3. Codes, Reference Standards, Definitions and Abbreviations
  - 4. Quality Assurance

**1.3 SCOPE OF WORK**

- A. This project requires the installation of a new Integrated Automation System (IAS) campus building network constructed on the campus' existing Tridium Niagara 4 Framework platform. The IAS system provided shall utilize BACnet certified field level control devices and Niagara JACE network controllers networked to the existing campus Niagara 4 Supervisor.
- B. Coordinate and work with other intelligent building controls systems to provide all required JACE's, web servers, and control components to allow for seamless control and communication at the graphic interface console. All labor, material, equipment and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, shall be provided without additional cost to the District.
- C. Provide integration of the Campus' scheduling software into the IAS. Refer to Section 25

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- D. Provide Fault Detection and Diagnostics for all equipment through the Districts preferred FD&D software. Refer to Section 250800.
- E. Provide Graphical User Interface Development for all of the devices identified above and illustrated within the IAS drawings. Refer to Section 25 15 00 and the Graphics Requirements Guideline A.
- F. Provide point naming and tagging for all hardware and logical control points and equipment provided under this project in accordance with the District standard. Refer to Guideline B.
- G. It is the contractor's responsibility to review all of the design documents and specifications and report any discrepancies to the District.

#### **1.4 GENERAL IAS INSTALLATION SCOPE OF WORK**

- A. The IAS components shall utilize JACE 8000 network controllers listed as a sole source product in the District's design and construction standards, enterprise connectivity, electronic sensing, microprocessor-based digital control, and electronic actuation of dampers and valves to perform control sequences and functions specified. The IAS will consist of monitoring and control of systems identified within the IAS drawings, which include integration of HVAC.
- B. The procurement and installation of Niagara 4 JACE Network Controllers and BACnet DDC control system devices for the project HVAC equipment. This includes all hardware, electrical installation, configuration, programming and commissioning coordination for the DDC system.
- C. Contractor shall integrate into the District Niagara 4 based open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. The District shall be the named license holder of all software associated with any and all incremental work on the project.
- D. The District shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, IAS Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the District.
- E. Intelligent Equipment Integration. Network installation, software integration, network communication, and equipment configuration for all equipment types specified to be integrated shall be provided with a factory installed or equipment manufacturer provided communication card. Refer to IAS drawings.
- F. Coordination with other trades to ensure that all equipment to be integrated is ordered with the proper communication cards and/or equipment required for proper integration.
- G. All hardware installed for the project shall be constructed in a modular fashion to permit the next generation and support components to be installed in replace of or in parallel

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with existing components.

- H. Provision of all documentation called out in these specifications including, but not limited to, submittals, O&M manuals, commissioning submittals, CAD based as-built documentation, and training manuals. Provide both hard copies and electronic files on electronic media.
- I. Training of facility personnel, and or maintenance contractor, on the operation and maintenance of the system as called out in these specifications.
- J. Hardware, Software and Labor as detailed and described on the IAS drawings and the Division 25 specifications.
- K. The repair of all finished surfaces effected as a result of IAS related installation work. This includes but is not limited to carpet, drywall, paint ceiling tiles, furniture, etc.
- L. DDC Controller programming and commissioning.
- M. System point to point check out, verification and documentation.
- N. Graphical User Interface Development. The Contractor shall develop the graphics, tools, features, and network integration required and as defined in section 25 15 00 and the MiraCosta Graphics Guideline.
- O. The low voltage and communication raceway systems, wiring and terminations.

## 1.5 QUALITY ASSURANCE

- A. Provide a Tridium Niagara 4 Framework as the basis of the new IAS. All IAS field level control devices provided shall be BACnet BTL listed.
- B. All microprocessor based control products used shall conform to BTL Certified Standards.
- C. The use of all proprietary equipment specified for the Integrated Automation System (IAS) integration shall be limited to devices and systems for which non-proprietary software drivers are available for the proposed Tridium Niagara 4 Enterprise infrastructure platform. It is the Contractor's responsibility to verify that the equipment manufacturers provide the appropriate interface boards as defined in these specifications and design drawings.
- D. The contractor shall provide hardware and software components of the same manufacturer wherever possible.
- E. The contractor shall use standard off-the-shelf components and/or products whenever possible. Custom products shall not be used unless approved prior to the installation.
- F. Materials and equipment shall be catalogued products and shall be the manufacturer's latest standard design that complies with the specification requirements. Where multiple units of the same type or function are required for this project, these units shall be products of a single manufacturer.
- G. All equipment shall be manufactured, installed and tested to comply with the acceptance testing requirements specified herein.

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- H. Product Line Demonstrated History: The product line being proposed for the Project must have an installed history of demonstrated satisfactory operation for a length of one (1) year since date of final completion in at least ten (10) installations of comparative size and complexity. Submittals shall document this requirement with references.
- I. The IAS and components shall be listed by the Underwriters Laboratories (UL 916) as an Energy Management System.

## 1.6 INSTALLER'S QUALIFICATIONS

- A. Integration Firm Qualifications: (provided by MiraCosta CCD Capital Improvement Program Team) The District's board of trustees approved the establishment of a pool of pre-qualified IAS contractors to provide labor, work, services, materials, equipment and the like for integrated automation system projects district-wide. All IAS work shall be performed by one of the prequalified firms. These pre-qualified contractors are listed below:
  - 1. Performance automation Solutions  
10633 Roselle Street Suite G,  
San Diego, CA 92121  
858-391-6407
  - 2. Climatec  
13715 Stowe Drive  
Poway, CA 92064  
858-391-7001
  - 3. Emcor Services Mesa Energy Systems  
900 Vernon Way  
El cajon, CA 92020  
619-980-2258
- B. Integration Engineer Qualifications: An integration Engineer shall oversee the design and installation of the integration system. The Integration Engineer shall have a minimum of five (5) years' experience with the installing company at an equal level of responsibility. The Integration Engineer shall have completed factory training for certification for the design, installation, start-up, and commissioning of the integration components to be installed. The Integration Engineer shall have experience in completing a minimum of two projects of similar size with the type of integration system specified for this project. Removal or replacement of Integration Engineer shall be subject to the District's approval.
- C. Installer's Experience with Proposed Product Line: The Firm must have a minimum of five (5) engineers or technicians that have successfully completed the Niagara certification course. Provide evidence of Niagara TCP certification as part of the submittal process. Proposed individuals must show proof of the following training:
  - 1. Product Line Training: Individuals overseeing the installation and configuration of the proposed product line must provide evidence of the most advanced training offered by the manufacturer(s) on that product line for installation and configuration.
  - 2. Programming Training: Individuals involved with programming the site-specific sequences shall provide evidence of the most advanced programming training offered by the vendor of the programming application offered by the manufacturer(s).

## 1.7 SUBMITTALS

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- A. General: Submit under provisions of Division 01. In addition, an electronic version of the completed materials shall be provided on electronic media. Data can be in native file format or scanned where necessary. Provide a complete and comprehensive submittal package. Partial submittals shall not be accepted. Upon completion submit all compliance data and project record documents.
- B. Preconstruction Submittals. Provide within 70 calendar days of contract award.
  - 1. Installer Qualifications: Key personnel qualifications as indicated for the appropriate items.
    - a. Submit validation which indicates the successful completion of the Tridium Niagara 4 certification course.
    - b. Submit resumes of installing staff indicating passing certificates for training on the BACnet line of controls to be installed as part of this project. Also include prior Instrumentation and Control experience.
    - c. Submit an organizational diagram indicating the key technical staff proposed for the project including Project Manager, Application Engineer, Programmers, Superintendent, etc. Provide staff quantities to be assigned to the project. Provide contact information for Managers, Programmers, and Lead Technicians. Provide local San Diego or Orange County service department address which will support the District.
  - 2. Proposed System Response Data: Provide guaranteed response times with Shop Drawings including calculations to support the guarantee.
  - 3. Point to Point Checkout Procedures: Provide written procedures and sample test forms for contractor testing specified herein.
- C. Construction Submittals
  - 1. Contractor Testing Reports
    - a. Point to Point Checkout Sheets: Submit results from Contractors testing specified herein. Submittal shall be signed by the contractor verifying that all testing has been completed and issues have been resolved.
    - b. HVAC System startup and TAB reports.
- D. Closeout Submittals
  - 1. DDC Operations and Maintenance Manual
    - a. Provide a written System Overview and Summary. The system overview and summary should be written descriptions of how each system operates, encompassing not only what is stated in the sequence of operations, but also including descriptions of any interlocks between systems (that are not covered in the sequences), fault conditions that require software resets (through the DDC system), fault conditions that require hardware resets (at the device), and any other descriptions of how the systems operate that are not covered in the sequences of operation. The system overview and summary should provide the data needed by the maintenance personnel to allow for the safe and efficient operation, maintenance, and repair of the system. It should be a quick reference for someone who has to respond to a trouble call, and should become the manual with which training can be conducted.
    - b. Preventative Maintenance Procedures: Recommended preventive maintenance procedures for all system components including a schedule of tasks for inspection, cleaning and calibration. Provide a list of recommended spare parts needed to minimize downtime. Provide a calibration records and list of set points.
    - c. Training Manuals: Submit the course outline and training material to the

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Owner for approval three (3) weeks prior to the training to District facility personnel. These persons will be responsible for maintaining and the operation of the control systems, including programming. The Owner reserves the right to modify any or all of the course outline and training material.

## 1.8 SYSTEM ARCHITECTURE

- A. The system provided shall incorporate hardware and software resources sufficient to meet the functional requirements of these Specifications. The FAC LAN and DLN shall be based on industry standard open platforms as specified herein and utilize commonly available operation, management and application software. All software packages shall be licensed to the Owner to allow unrestricted maintenance and operation of the IAS. Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications, including but not limited to:
1. Network Operating software
  2. Device Drivers and Plug-ins
  3. File Server Software
  4. Graphical User Interface (GUI) and Utility software
  5. Network Management, Configuration, Controller/System Programming and Utility software.
  6. Original electronic media and licenses for all software packages utilized to implement the IAS
- B. The system architecture shall provide a campus IAS network which is based on the Niagara 4 Framework and consists of an Ethernet-based, wide area network (WAN), a single Local Area Network (LAN) that supports JACEs, AACs, ASCs, Operator Workstations (OWS), Smart Devices (SD), and Remote Communication Devices (RCDs) as applicable. The following indicates a functional description of the existing IAS structure. The contractor shall utilize these components of the IAS for the scope of this project.
1. WAN: Internet-based shared network connecting multiple campus facilities with a central data warehouse and server, accessible via standard web-browser. This is an existing infrastructure and Contractor is required to perform the necessary configuration to connect to the central IAS Niagara 4 server.
  2. Facility Local Area Network (FAC LAN): The FAC LAN shall be an Ethernet-based, 10/100/1000 Ethernet LAN connecting Local JACEs, IAS Server and OWSs. The FAC LAN serves as the backbone for the JACE's, communications path and as the connection point to the WAN. Contractor shall provide this as a dedicated LAN for the control system. LAN shall be IEEE 802.3 Ethernet over Fiber or Category 6 cable with switches and routers that support 1000base-T gigabit Ethernet throughput.
  3. The FAC LAN must be installed in accordance with IEEE 802.3, TIA/EIA 568-B and TIA/EIA 569-A. The FAC LAN shall support multiple NCs and OWS.
  4. Device Level Network (DLN): Network used to connect AACs and ASCs. These shall be Master Slave devices as defined in the BTL standard.
- C. Dynamic Data Access: Data throughout any level of the network shall be available to and accessible by all other devices, Controllers and OWS, whether directly connected or connected remotely as defined in the point list schedules.
- D. Remote Data Access: The system shall support the Internet Browser-based remote access to the building data.



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- E. Browser-based access: A remote/local user using a standard browser will be able access all control system facilities and graphics via the WAN or direct connection, with proper username and password. Only Internet browser-based user interfaces (HTML5, Java, XML, CCS3 JAVA Script, etc.) are acceptable. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
- F. The communication speed between the controllers, LAN interface devices, CSS, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. Contractor shall submit guaranteed response times with Shop Drawings including calculations to support the guarantee. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein. Contractor shall reconfigure LAN as necessary to accomplish these performance requirements:
1. 5 seconds between an operator selection of a graphic and it completely painting the screen and updating a minimum of forty (40) points.
  2. 5 seconds between a Level 1 (critical) alarm occurrence and enunciation at operator workstation.
  3. 10 seconds between a Level 2 alarm occurrence and enunciation at operator workstation.
  4. 20 seconds between a Level 3-5 alarm occurrence and enunciation at operator workstation.
  5. 10 seconds between an operator command via the operator interface to change a setpoint and the subsequent change in the controller.
  6. 5 seconds between an operator command via the operator interface to start/stop a device and the subsequent command to be received at the controller.
  7. 10 seconds between a change of value or state of an input and it being updated on the operator interface.
- G. Tridium Niagara 4 Control Systems Server (CSS): A server that maintains the systems configuration and programming database. It holds the backup files of the information downloaded into the individual controllers and as such support uploading and downloading that information directly to/from the controllers. It also acts as a control information server to non-control system based programs. It shall allow secure multiple-access to the control information. The Contractor shall provide all required programming and configuration of the CSS to integrate the project facility into the IAS campus network.
- H. The Operator Interface shall provide for overall system supervision, graphical user interface, management report generation, alarm annunciation, and remote monitoring. The system shall be capable of supporting an unlimited number of clients using a standard Web browser including Internet Explorer™, FireFox™ and Chrome™.
- I. The PCUs, AACs, ASCs, BCs, and SDs shall monitor, control, and provide the field interface for all points specified. Each BC, AAC, or ASC shall be capable of performing all specified energy management functions, and all DDC functions, independent of other PCUs, AACs, or ASCs and operator interface devices.
- J. Systems Configuration Database: The system architecture shall support maintaining the systems configuration database on a server that resides on the FAC LAN. User tools for DLN and FAC LAN management shall be provided and licensed to the Owner and shall

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allow unrestricted configuring, updating, maintaining, and expanding of all current devices, configurations and settings.

- K. Database Schema shall be published and provided to the Owner to facilitate easy access to DLN and FAC LAN data.
- L. All line drivers, signal boosters, and signal conditioners etc. shall be provided as necessary for proper data communication.

## 1.9 SUBSTITUTIONS

- A. Wherever the words "for review" or "for acceptance" are used in regard to manufactured specialties, or wherever it is desired to substitute a different make or type of apparatus for that specified, submit all information pertinent to the adequacy and adaptability of the proposed apparatus to the Owner's Representative and secure their approval before the apparatus is ordered. Refer to general condition requirements for substitutions.
- B. Wherever system performance such as material quantities, operating pressure, network throughput, or the like are specified, or a definite make and size of apparatus is specified, for which such quantities are readily determinable, the make and size of the apparatus proposed must conform substantially to the quantities specified or implied. Critical dimensions relating to the installation of apparatus and coordination with the rest of the system shall be considered and adhered to. Substitution of equipment or apparatus shall include all necessary revisions and their costs required to complete the installation.
- C. Approval of request for substitutions may be given only after receipt of complete and satisfactory performance data covering the complete range of operating conditions in tabular and graphical form. Furnish complete and satisfactory information relative to equipment performance, features and accessories, etc. Additional construction and design costs incurred as a result of any accepted substitution shall be borne by the Contractor.
- D. Substitution Format: Proposed changes and substitutions of systems, apparatus, equipment and manufacturers will be considered subject to the approval of Owner's representative. The proposal shall include the following information:
- E. A description of the difference between the existing contract requirements and that proposed, the comparative features of each, and the effect of the change on the end result performance. Include the impact of changes on other Contractors and/or subcontractors and acknowledge the inclusion of implementation costs.
  - 1. Schematic drawings and details to supplement the descriptions.
  - 2. A list of the contract requirements that must be revised if the change is accepted, including any suggested specification revisions.
  - 3. Complete list of materials and equipment proposed for use in the change.
  - 4. Include a description and estimate of costs Owner may incur in implementing the change, such as test, evaluation, operating and support costs.
  - 5. A projection of any effects the proposed change would have on collateral costs to the Owner.
  - 6. A statement of the time by which a contract modification accepting the change must be issued, noting any effect on the contract completion time or the delivery schedule.
  - 7. A statement indicating the reduction to the contract price if the Owner accepts the change. The Contractor shall be responsible for appropriate modification of subcontractor.

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## 1.10 CODES

- A. Comply with all current codes, ordinances, regulations, and the California Building Code. In all cases of conflict between the work of this Division and the California Building Code, or omission of items required for code compliance, details shall be brought to the attention of the Owner or Owner Representative at the time of bid proposal submission. It is the Contractor's responsibility to identify any items of conflict or omission. These items shall be resolved prior to bid submission and included in the bid proposal price.
- B. The IAS work shall comply with all applicable requirements of the following codes. The latest edition is assumed unless stated otherwise or as amended by the Local Code Authorities.
  - 1. UL 864 – Control Units for Fire Protective Signaling Systems
  - 2. UL 916 – Energy Management
  - 3. NFPA 91A – Recommended practice for smoke control systems
  - 4. ADA – Americans with Disabilities Act
  - 5. UL 508A – Manufacturer listed control panel
  - 6. EIA/TIA-568 – Commercial Building Wiring Standard
  - 7. ASHRAE – American Society of Heating Refrigerating and Air Conditioning Engineers
  - 8. ANSI/ASHRAE Standard 135- BACnet
  - 9. EMC Directive 89/336/EEC (European CE Mark)
- C. Where codes are listed herein, the applicable portions of the latest editions apply.
- D. Drawings, specifications, codes and standards are minimum requirements. Where requirements differ, apply the more stringent.
- E. Should any change in Drawings or Specifications be required to comply with regulations, the Contractor shall notify the Owner prior to execution of the work and wait for direction from the Owner.

## 1.11 REFERENCED STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
  - 1. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standard 135, BACnet – A Data Communication Protocol for Building Automation and Control Networks
  - 2. American National Standards Institute (ANSI)
  - 3. American Society of Mechanical Engineers (ASME)
  - 4. American Society for Testing and Materials (ASTM)
  - 5. American Refrigeration Institute (ARI)
  - 6. EIA-709.1-A-99: Control Network Protocol Specification
  - 7. EIA-709.3-99: Free-Topology Twisted-Pair Channel Specification
  - 8. EIA-232: Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange
  - 9. EIA-458: Standard Optical Fiber Material Classes and Preferred Sizes

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10. EIA-485: Standard for Electrical Characteristics of Generator and Receivers for use in Balanced Digital Multipoint Systems
11. EIA-472: General and Sectional Specifications for Fiber Optic Cable
12. EIA-475: Generic and Sectional Specifications for Fiber Optic Connectors and all Sectional Specifications
13. EIA-573: Generic and Sectional Specifications for Field Portable Polishing Device for Preparation Optical Fiber and all Sectional Specifications
14. EIA-590: Standard for Physical Location and Protection of Below-Ground Fiber Optic Cable Plant and all Sectional Specifications
15. UL 916: Energy Management Systems
16. NEMA 250: Enclosure for Electrical Equipment
17. NEMA ICS 1: General Standards for Industrial Controls
18. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences
19. NFPA 70 National Electrical Code (NEC)
20. Instrument Society of America (ISA)
21. IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems
22. IEEE 802.3: CSMA/CD (Ethernet – Based) LAN
23. IEEE 519: Recommended Practices and Requirements for Harmonic Control in Electric Power Systems
24. Joint Industrial Council (JIC)
25. BACnet Testing Lab
26. Occupational Safety and Health Act (OSHA)
27. Federal Communications Commission Parts 15 and 16

## 1.12 COORDINATION OF WORK WITH OTHER TRADES

- A. Examine and compare the Integrated Automation System (IAS) Specifications and Drawings with the Specifications and Drawings of the other trades and report any discrepancies between them to the Owner. Obtain the Owner's written instructions for changes necessary in the IAS work. Install and coordinate the IAS work in cooperation with the Commissioning Authority and the other trades installing interrelated work. Before installation, make proper provisions to avoid interferences in a manner approved by the Owner. All changes required in the work of the Contractor, caused by noncompliance with the specifications, shall be made at the Contractor's expense.
- B. Certain products, systems and interface devices may be provided by other trades. Examine the Contract Documents to ascertain the requirements to install, wire, program, commission, and/or interface to these systems. Particular attention must be paid towards the interface boards submitted by the various equipment providers. It is the IAS Contractor's responsibility to verify the submitted interfaces will integrate properly into the IAS. Report any discrepancies to the Owner.
- C. Carefully check space requirements with other trades to insure that all material can be installed in the allotted spaces, including above finished suspended ceilings and under floors.
- D. Wherever work interconnects with work of other trades, coordinate with other trades and with the Owner's representative to insure that all trades have the information necessary so that they may properly install all the necessary connections and equipment. Identify all work items (valves, dampers, coils, etc.) in an accepted manner and notify the responsible trade to install access doors and panels at these locations. Provide notification in writing to both the contractor and the Owner of these locations.

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- E. Provide sleeves and conduit for passage of pipes, and wiring through structural masonry, concrete walls and floors, and elsewhere for the proper protection of the IAS work.
- F. Coordinate project and schedule work with other trades and with the Commissioning Authority in accordance with the construction sequence.
- G. Adjust locations of panels, equipment, devices, and the like, to accommodate work and prevent interferences. Determine the exact route and location of each pipe, conduit or tubing prior to fabrication and installation.

### **1.13 GENERAL**

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

### **1.14 MATERIALS AND EQUIPMENT**

- A. Materials shall be new, the best of their respective kinds without imperfections or blemishes, and shall not be damaged in any way. Used equipment shall not be used in any way for the permanent installation except where Drawings or Specifications specifically allow existing materials to remain in place.

### **1.15 UNIFORMITY**

- A. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- B. These specifications call out certain duties of the Contractor and any subcontractor(s). They are not intended as a material list of all items required by the Contract.

### **3.2 INSTALLATION**

- A. Utilize licensed electricians for all new and retrofitted electrical distribution systems. Installations of high and low voltage systems shall be in accordance with all building code requirements. Obtain electrical permits, if required by local authorities.
- B. Provide related items and work indicated on the IAS Drawings and items and work called for in this Division of the Specifications. This includes all incidentals, equipment, appliances, services, hoisting, scaffolding, supports, tools, supervision, labor, consumable items, fees, licenses, etc., necessary to provide complete systems. Perform start up, configuration, programming and commissioning coordination on each control product and system to provide fully operable systems in accordance with the specified

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functional performance.

- C. Comply with Federal, State, Municipal and other applicable codes and ordinances. If any conflict arises between these Specification and Drawings, and codes and ordinances, immediately notify the Owner's Representatives. Do not deviate from the Drawings and Specifications nor install any work which may be in conflict with codes and ordinances until the conflict is resolved and the solution accepted by the Owner.
- D. The IAS Drawings show the general arrangement of the respective systems. Follow these Drawings as closely as actual building construction and the work of other trades will permit. Provide devices, fittings, sensors, controllers, wiring and accessories, which may be required but are not shown on the Drawings or specified herein. The Contractor shall be responsible for achieving the sequence of operations and intent of the system design. Investigate conditions affecting the work and arrange the work accordingly. Provide modifications and accessories as may be required to meet such conditions.
- E. All installation shall be in accordance with manufacturer's published recommendations.
- F. Limit LAN cable lengths to no longer than 80% of the longest dimension published by the manufacturer of the cable between the most remote network nodes.

### **3.3 DIGITAL CONTROL PANELS, CONTROLLER QUANTITY AND LOCATION**

- A. Individual Digital Control Panels (DCP) are referenced to indicate allocation of points to each DCP and DCP location. Digital control panels shall consist of one or multiple controllers to meet requirements of this Specification.
- B. Where a DCP is referenced, Contractor shall provide at least one (1) controller, and additional controllers as required, in sufficient quantity to meet the requirements of this Specification. Contractor shall extend power to the DCP from an acceptable power panel. Furthermore, Contractor is responsible for ensuring adequate locations for the panels that do not interfere with other requirements of the Project and maintain adequate clearance for maintenance access.
- C. Contractor shall locate DCPs as referenced. It is the Contractor's responsibility to provide enough controllers to ensure a completely functioning system, according to the point list and sequence of operations.

### **3.4 NETWORK MANAGEMENT FUNCTIONAL REQUIREMENTS**

- A. The Contractor shall coordinate the setup and configuration of the IAS local area network hardware to permit the functional requirements of the IAS herein specified. The setup shall include as a minimum the following network management procedures:
  - 1. Automatic backup of the DDC System database to appropriate media.
  - 2. Program, load and debug all software installations.
  - 3. Network user auditing routine.



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### **3.5 SURGE PROTECTION**

- A. Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all NCs, operator interfaces, printers, routers and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10 percent above or below measured nominal value, with no effect on hardware, software, communications, and data storage.

### **3.6 CONTROL POWER SOURCE AND SUPPLY**

- A. IAS Contractor shall extend all power source wiring required for operation of all equipment and devices provided under Division 25 and the Drawings.
- B. General requirements for obtaining power include the following:
  - 1. In the case where additional power is required, obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 480V source, obtain power from the electrically most proximate 120V source fed from a common origin.
  - 2. Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source of power as the equipment. If the equipment's control transformer is large enough and is the correct voltage to supply the controls, it may be used. If the equipment's control transformer is not large enough or of the correct voltage to supply the controls, or is too noisy for reliable control, provide a separate transformer.
  - 3. Where a controller controls multiple systems on varying levels of power reliability (normal, emergency, and/or interruptible), the controller shall be powered by the highest level of reliability served.
  - 4. Standalone Functionality: Refer to Section 25 14 00.

### **3.7 PRODUCT DELIVERY, STORAGE, HANDLING, PROTECTION AND CLEANING**

- A. All products and materials shall be new, clean, and free of defects, damage and corrosion.
- B. Ship and store products and materials in a manner which will protect them from damage, weather, and entry of debris. Do not install damaged items - take immediate steps to obtain replacement or repair.
- C. The Contractor shall provide adequate means for and shall fully protect all finish parts of the materials and equipment against damage from any cause during the progress of the work until final acceptance. All materials and equipment in storage and during construction shall be covered in such a manner that no finished surfaces will be damaged or marred, and all moving parts shall be kept clean and dry. The Contractor is responsible for providing storage of materials and equipment.
- D. Equipment and accessories shall be thoroughly cleaned of cement, plaster, and other materials; grease and oil spots shall be removed with cleaning solvent and surfaces carefully wiped.
- E. Panels housing electronic controllers shall be constructed so that the panel and associated wiring may be installed independent of the installation of the electronics. The installation of electronics shall be coordinated with other trades and construction

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schedules to avoid damage

### **3.8 CONTRACTOR TESTING**

- A. Point to Point Checkout Requirements:
  - 1. These procedures will verify the following for each physical control point
    - a. Field Device is installed per the manufacturer's recommendations and the project drawings and specifications
    - b. Field verify calibration of all analog inputs and outputs
    - c. Verify labelling of controllers, field devices, and wiring
    - d. Physical points are correctly addressed and communicating properly between its controller and the field device
  - 2. Detailed written procedures for execution of Point-to-Point checkouts shall be submitted by the contractor for review and acceptance prior to the start of testing. Include proposed test forms as part of this submittal.
  - 3. The contractor shall provide all tools and instrumentation necessary for execution of this testing. All instrumentation must be in calibration.
  - 4. The contractor shall sign and submit all final reports confirming that Point-to-Point testing was conducted, and all issues have been resolved. Owner functional testing shall not proceed until all contractor test reports have been submitted.

### **3.9 SITE CLEAN UP**

- A. At conclusion of each day's work, clean up and remove from the site all rubbish, debris and trash accumulated during the day as a result of work of the Contractor. Sidewalks and streets adjoining the property shall be kept broom clean and free of debris, rubbish, trash and obstructions of any kind caused by work of this Contract.
- B. Upon completion of the work and at times during progress of the work when requested by the Owner, the Contractor shall remove all surplus materials, rubbish, and debris resulting from the operation, and shall leave the entire building and involved portions of the site, insofar as the work of the Contract is concerned, in neat, clean and acceptable condition as approved by Owner.
- C. Marks on walls or ceiling tiles caused by the Contractor shall be cleaned by the Contractor. Ceiling tiles, drywall, carpet, paint, and all architectural finishes damaged by the Contractor shall be replaced by the Contractor.

**END OF SECTION 25 00 00**



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**SECTION 25 06 00**  
**NETWORK SCHEDULING SOFTWARE FOR HVAC**

**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.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.
- C. Related Specifications:
  - 1. Section 250000 – Integrated Automation Systems (IAS) for HVAC
  - 2. Section 250800 – Fault Detection and Diagnostics Software for HVAC
  - 3. Section 251400 – IAS Network Controllers for HVAC
  - 4. Section 251500 – IAS Software and Programming Tools for HVAC

**1.2 SUMMARY**

- A. The existing campus 25 Live classroom scheduling software system and the project installed DDC control systems shall be integrated directly so that the scheduled room event reservations entered in the reservation system will automatically schedule the required HVAC systems to turn on and off for those events. The integration software shall be installed on a Windows server platform and will periodically query the current day's event schedules and command the appropriate HVAC equipment for the scheduled rooms automatically without operator interdiction.
- B. The contractor shall procure and install the software and link the schedules of DDC equipment serving spaces scheduled through the 25Live software to automatically place the associated equipment and zones in standby mode in between classes during normally occupied periods.

**1.3 SUBMITTALS**

- A. General: Submit under provisions of Division 01. In addition, an electronic version of the completed materials shall be provided on electronic media. Data can be in native file format or scanned where necessary. Provide a complete and comprehensive submittal package. Partial submittals shall not be accepted. Upon completion submit all compliance data and project record documents.
- B. Preconstruction Submittals: Provide within 70 calendar days of contract award.
  - 1. Product Data
    - a. Submit product data of the scheduling integration software.
    - b. Provide a network architecture indicating how the software will interface on MiraCosta's network, the Niagara 4 server, and the 25 Live scheduling software.

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## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. All materials shall meet or exceed all applicable referenced standards, Federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

### **2.2 NETWORK SCHEDULING SOFTWARE**

- A. The network scheduling interface software shall be Events2HVAC. Events2HVAC is listed a sole-source product in the District's design and construction standards. Alternate products will not be considered acceptable.
- B. Supported Reservation Systems: The interface software will support the following reservations systems and multiple instances of the same type of system
  - 1. CollegeNet Resource25/25Live web services
  - 2. Ad Astra Information Systems
  - 3. eSPACE
  - 4. Asure ResourceScheduler
  - 5. ShelbyNext
  - 6. SimpleChurchCRM
  - 7. FellowshipOne Go
  - 8. Microsoft Exchange (via Room Resources)
  - 9. Google (G Suite) Business Calendar (via Room Resources)
  - 10. Google Personal Calendar
  - 11. Manual schedule import using CSV format
  - 12. Other open API systems
- C. Minimum Features: The interface software shall be programmed with the following minimum features.
  - 1. Commands to HVAC system points can be issued at any or all of the following instances during an event:
    - a. Event Setup Start
    - b. Event Setup End
    - c. Event Start
    - d. Event End
    - e. Event Teardown Start
    - f. Event Teardown Stop
    - g. Zone First Start (Daily)
    - h. Zone Last Stop (Daily)
    - i. Zone First Setup Start (Daily)
    - j. Zone First Teardown Stop (Daily)
  - 2. Each command to HVAC system points can be started in advance of the event (Pre-Start time)
  - 3. Each command to HVAC system points can be stopped after a period of time after the event ends (Post-Stop time)
  - 4. Multiple rooms can be associated with a single HVAC equipment item or zone
  - 5. Multiple reservation systems or instances of reservation systems can be queried for control of zones
  - 6. User defined password-based, role-based security
  - 7. Software shall be generate the following reports on demand or in PDF format
  - 8. Daily event report
  - 9. Daily equipment command report
  - 10. Room Assignment report
  - 11. Equipment Detail report

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12. Software shall email users if any scheduled commands fail to get executed
13. Software shall email users the Daily reports above
14. Software can aggregate multiple reservation systems and multiple instances of a reservation system into common HVAC schedules
15. Software shall store locally at least 7 days of backup schedule data from the reservation system in the event of a loss of communication with the reservation system.

## **PART 3 - EXECUTION**

### **3.1 HVAC IAS INTEGRATION**

- A. The contractor is responsible for exposing (serving) the integrated room HVAC equipment objects in the accepted protocol. The contractor shall ensure that the system has the necessary communications protocols enabled across the network to allow point discovery and point read/write operations to the integrated objects.
- B. Example: If the BACnet/IP protocol is used, the controlled point objects must be visible and writeable from the integration software client. Also, a BBMD may need to be enabled and defined on the BACnet network to allow a BACnet client to discover objects over different LAN segments.
- C. The contractor is responsible for selecting the appropriate point objects that would be integrated and defining the priority for the commands coming from the integration software. Any potential safety issues or mechanical issues that could result from commands coming from the integration server shall be addressed using additional HVAC logic or programming to prevent unintended operations.
- D. The contractor is responsible for programming and documenting a reasonable switchover method from automatic scheduling (dynamic schedules) to default building schedules in the event of a problem with the integration server or communication between building controllers and the integration server (for communication loss, server failure, or user requirements, etc.). A schedule status signal or heartbeat signal at the integration server will be generated by the integration software for automating the switchover.
- E. The contractor is responsible for providing a list of integration points for each zone in Excel or CSV file format that includes: point name, point type, rooms served, point ID, occupied Mode value, Unoccupied Mode value, priority for writing, and a typical pre-start time in minutes. This list shall be used by the contractor to map the reservation system rooms to the required points for control.

### **3.2 IT NETWORK INTEGRATION**

- A. The contractor is responsible for enabling necessary TCP/IP traffic to pass through any hardware firewalls, PC firewalls, switches and routers that may be between the integration server, the room scheduling system and the HVAC system.

**END OF SECTION 25 06 00**

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## **SECTION 25 08 00**

### **FAULT DETECTION AND DIAGNOSTICS (FDD)**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This specification identifies the requirements for incorporating embedded Fault Detection and Diagnostics (FD&D) software across the IAS control system network. The purpose is to provide a consistent, standardized methodology for analyzing the historical trend database data points to identify and address faults or deficiencies associated with DDC automation systems. The purpose of the analytic software application is to analyze energy, and equipment operational data to identify faults and opportunities for improved performance and reduced energy use in the operation of building systems.
- B. Fault Detection and Diagnostics (FD&D) analytic software application is to provide verification that energy conservation measures (ECM's) are executing as expected through the analysis of energy usage at the point of use, identification of faults showing where control sequences are not functioning as prescribed, and identification of opportunities for improved performance in the operation of building systems.
- C. Related Sections include the Following:
  - 1. Section 250000 – Integrated Automation System (IAS) for HVAC
  - 2. Section 250600 – Network Scheduling Software for HVAC
  - 3. Section 251400 – IAS Network Controllers for HVAC
  - 4. Section 251500 – IAS Software and Programming Tools for HVAC
  - 5. Guideline B – IAS Point Tagging Requirements

##### **1.2 DEFINITIONS**

- A. API Application Program Interface
- B. CSV Comma Separated Value
- C. EDI Electronic Data Exchange
- D. DDC Facility Management and Control System
- E. M&V Measurement and Verification
- F. REST Representational State Transfer
- G. SaaS Software as a Service
- H. SQL Standard Query Language
- I. XML Extensible Markup Language

##### **1.3 QUALITY ASSURANCE**

- A. Installing Company Qualifications
  - 1. Experience in completing a minimum of three local projects of similar size with the type of FD&D system specified for this project within the last five years.

##### **1.4 SUBMITTALS**

- A. Preconstruction Submittals
  - 1. FD&D Graphics Submittal: A copy of each of the FD&D graphics developed for the Graphic User Interface including a flowchart (site map) indicating how the graphics are to be linked to one another for system navigation. The graphics are intended to be 80% - 90% complete at this stage with the only remaining

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changes to be based on review comments from the A/E design team and/or Owner.

2. Shop Drawings: Shall include the following:
    - a. Product data.
  3. FD&D Sequence of Operations: A complete written Sequence of Operation describing each fault rule and its programming.
- B. Construction Submittals
1. Point Validation Log: Log of tests conducted verifying 100% of the input and output points of the FD&D system operation. Contractor shall sign log indicating all issues have been addressed and system is ready for owner witness testing.
  2. Standard Reports: Provide all standard reports including all time data and duration of all faults for a minimum of 72hours.
- C. Closeout Submittals
1. Training Manuals
  2. O&M Data

## 1.5 SOFTWARE LICENSE AGREEMENT

- A. It is the Owner's express goal to implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the FD&D system. Any and all required IDs and passwords for access to any component or software program shall be provided to the Owner.

## PART 2 - MATERIALS

### 2.1 MANUFACTURERS

- A. The fault detection and diagnostics software shall be based on SkySpark from SkyFoundry, fully integrated into the DGLux graphical user interface using Skyspark's REST-based API which the DGLux software can use. SkySpark is listed as a sole-source product in the District's design and construction standards. Alternate products will not be considered acceptable.
1. SkySpark by SkyFoundry is a FD&D software where "rules" are created using text-based source code that automatically run against collected data. The software comes with a large library of pre-programmed analytic functions and mathematical algorithms. It employs semantic tagging, pattern recognition, functional rules processing and other techniques.

### 2.2 PLATFORM REQUIREMENTS

- A. The software application shall provide the following features and capabilities as a minimum:
1. GUI Integration – The software front end shall be integrated and operated through the specified DGLux 5 user interface software. FD&D software which require a separate user interface or log-in are not acceptable. Also, It shall not be acceptable to provide stand-alone instances of the SkySpark software.

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2. Operating Systems - The analytic software application shall operate on current versions of Windows and Linux operating systems.
  3. Time series database - The analytic software application shall utilize a database technology designed for the efficient storage and analysis of large volumes of time series data. It shall not employ a relational database structure but shall instead use tagging to model and describe data and shall support the use of the open source tagging standard. The FD&D software application shall use tagging to model and describe data and shall support the use of the open source tagging standard Project Haystack. Refer to Guideline B.
  4. Data Import - The analytic software application shall accept and normalize data from a variety of sources including SQL compatible data bases, CSV format files, XML format files or web services, and other EDI techniques. Once imported the software shall provide a unified data format to enable analytics algorithms to identify patterns across those different data sets. The software shall import data directly from the DDC SQL historian server.
  5. Open interfaces - The analytic software application shall provide open, REST-based API's to enable integration with third party software applications. The open APIs shall enable data to be entered/imported into the database, exported from the database, posting of analytic queries and output of analytic results. APIs shall be fully documented and available as part of the standard product.
  6. Hosted – SaaS or local deployment. The Skyspark is currently hosted offsite by Ecovox. Due to offsite hosting, the bidding IAS contractor will not have direct access to the hosting server. Contact Ecovox for details – (805)540-2044. Provider shall include 60 months of software subscription for additional points within the costs of their proposal.
- B. Weather Data Service - The analytic software application shall include a built in subscription to a worldwide weather service providing weather data for all major metropolitan areas. Weather service shall provide an update frequency of at least every 3 hours.
1. Weather data shall include:
    - a. Current temperature
    - b. High temperature for the day
    - c. Low temperature for the day
    - d. Sunrise and sunset times
    - e. Relative Humidity
    - f. Degree days (heating and cooling with adjustable balance point value)
  2. The weather service shall include a three day forecast and provide historical weather data extending back at least 1 year.
- C. Email notification - The analytic software application shall provide automatic notification of detected issues via email.
1. Email notification services shall as a minimum provide:
    - a. Immediate notification of detected issues
    - b. Daily digest or summary of detected issues
    - c. The ability to delineate which issue notifications are sent to which recipients down to the level of specifying individual issues are sent to individual recipients.

## 2.3 HARDWARE REQUIREMENTS

- A. The FD&D software shall reside on the DDC server.

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## 2.4 ANALYTIC RULES

- A. Standard Analytic Functions - The analytic software application shall provide a library of standard analytic functions. The following standard analytical functions shall be developed and applied to all integrated systems at MiraCosta College:
  - 1. Equipment Operation
    - a. Simultaneous Heating and Cooling
    - b. Short Cycling of Equipment
    - c. Degradation of Heating or Cooling Performance
    - d. Non-Optimal Economizer Operation
    - e. Non-Functioning Sensors
    - f. Setpoints Overridden
    - g. Equipment not Operating with Schedules
    - h. Leaking Valves
  - 2. Energy Performance and M&V
    - a. Deviation of Energy Intensity from Baselines or Goals
    - b. Weather Normalization of Energy Use
    - c. Energy Savings Compared to Baseline
- B. Custom Rule Development – Boiler System
  - 1. The following rules shall be applied to all heating hot water plants:
    - a. Hot Water DP Setpoint Not Met
    - b. Boiler Status Doesn't Match Command
    - c. Hot Water Leaving Temp Setpoint Not Met
    - d. Pump Speed Override
    - e. Pump Speed Doesn't Match Command
    - f. Pump Off When Commanded On
    - g. Pump On When Commanded Off
    - h. HHW Broken Valves and sensors
    - i. HHW Outdoor air temperature set-point optimization
    - j. HHW equipment-short cycling
- C. Custom Rule Development – Closed Circuit Cooling Tower Plants
  - 1. The following rules shall be applied to all air cooled chilled water plants:
    - a. Condenser Water DP Setpoint Not Met
    - b. Condenser Water Leaving Temp Setpoint Not Met
    - c. CW Pump Issue - Speed Too High
    - d. Pump Speed above 90% 30 min
    - e. Primary CHW Flow Sensor Failure
    - f. Condenser Water Entering Temp Sensor Failure
    - g. Condenser Water Flow Sensor Failure
    - h. Condenser Water leaving Temp Sensor Failure
    - i. Cooling Tower Status Doesn't Match Command
    - j. Constant VFD Speed
    - k. Chilled Water DP Setpoint Not Met
    - l. Pump Speed Override
    - m. Pump Speed Doesn't Match Command
    - n. Pump Off When Commanded On
    - o. Pump On When Commanded Off
    - p. CW GPM/Ton Low

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- q. CW GPM(Ton High)
- r. CW low Delta T
- s. Cooling Tower issue - Peak Demand
- t. CW Plant Efficiency
- u. CW Supply temp set-point optimization
- v. CW abnormal pump current
- w. CW broken valves and sensors
- x. CW equipment short-cycling
- D. Custom Rule Development –Water Source Heat Pumps
  - 1. The following rules shall be applied to all fan coils:
    - a. Analog Damper Control Oscillation
    - b. Low Temp Drop Across Cooling Coil
    - c. Cooling Capacity Not Met
    - d. DAT Hunting
    - e. Condenser Water Valve Out of Range
    - f. Zone Air Temp Sensor Failure
    - g. Supply Air Temp Too Warm
    - h. Supply Fan Off When Commanded On
    - i. Supply Fan On When Unoccupied
    - j. Supply Fan On When Commanded Off
    - k. Terminal Broken sensors
    - l. Terminal Poor scheduling
    - m. Terminal Poor Temperature Set Points

## 2.5 REPORTING

- A. Standard Views of Analytic Results - The analytic software application shall include standard views to present analytic results, which shall be automatically generated when issues are found by analytic rules.
- B. These views shall include as a minimum:
  - 1. All rule violations across a portfolio of sites, all rules violations per site, including time, date and duration of all violations.
  - 2. The ability to assign cost relationships to rule logic to provide cost per violation.
  - 3. Standard filters to enable the user to easily look at rule violations by site, data, violation type for any selected date or date range.
  - 4. Automatic calculation and presentation of Key Performance Indicators. It shall be possible to define custom KPIs as needed.
- C. Custom Views of Analytic Results
  - 1. The analytic software application shall allow for the creation of custom reports and data views. Any standard system view shall be able to be saved as a custom report including its configuration criteria, e.g., time range, sites, rule violations or other configuration options as applicable to the standard system view.
  - 2. Custom reports shall be able to be created by making queries against the database and saving the query as a saved report. Saved reports shall be able to be executed by typical system users with a single mouse click.
  - 3. Exporting - The system shall allow for the export of any and all report views and shall support export in CSV, Excel, XML and HTML format. Export of report views shall be a feature available to the typical operator and be able to be accomplished with 2-3 mouse clicks.

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## **PART 3 - EXECUTION**

### **3.1 WIRING**

- A. All electrical control wiring and power wiring to the FD&D, computers and network components shall be the responsibility of the FD&D contractor.
- B. The contractor shall furnish all power wiring to FD&D controllers.
- C. All wiring shall be in accordance with the National Electrical Code and any applicable local codes. All FD&D wiring shall be installed in the conduit types allowed by the National Electrical Code or applicable local codes. Where FD&D CS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

### **3.2 WARRANTY**

- A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.
- B. Within this period, upon notice by the Owner, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by the contractor at no expense to the Owner.

### **3.3 WARRANTY ACCESS**

- A. The Owner shall grant to the contractor, reasonable access to the FD&D system during the warranty period. The owner shall allow the contractor to access the FD&D system from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

### **3.4 SOFTWARE LICENSE**

- A. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s).
- B. The owner, or his appointed agent, shall receive ownership of all job specific software configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project. Any and all required Ids and passwords for access to any component or software program shall be provided to the owner.

### **3.5 ACCEPTANCE TESTING**

- A. Upon completion of the installation, the contractor shall load all system software and start-up the system. The contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.
- B. The contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the FD&D system operation.
- C. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in the presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.
- D. System Acceptance: Satisfactory completion is when the contractor has performed successfully all the required testing to show performance compliance with the

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requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

### **3.6 OPERATOR INSTRUCTION, TRAINING**

- A. During system commissioning and at such time acceptable performance of the FD&D system hardware and software has been established the contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done in series with the required DDC system training and shall be performed by a competent representative familiar with the system hardware, software and accessories.
- B. The contractor shall provide 12 hours of instruction to the owner's designated personnel on the operation of the FD&D and describe its intended use with respect to the programmed functions specified. Operator orientation of the FD&D system shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.
- C. The training shall be in two sessions as follows:
  - 1. Initial Training: One day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the owners' personnel can start to familiarize themselves with the system before classroom instruction begins.
  - 2. First Follow-Up Training: One half-day (4 hours total) approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.

**END OF SECTION 25 08 00**

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## **SECTION 25 11 00**

### **IAS INSTRUMENTATION AND CONTROL DEVICES FOR HVAC**

#### **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.
- B. Related Specifications:
  - 1. Section 250000 – Integrated Automation Systems (IAS) For HVAC
  - 2. Section 251400 – IAS Network Controllers for HVAC
  - 3. Section 251500 – IAS Software and Programming Tools for HVAC

##### **1.2 SUMMARY**

- A. Contractor shall supply and install the components listed in this section, and those identified on the project drawings, in adequate quantities as required to meet the sequence of operation and the design/performance intent of the MEP systems as they pertain to the IAS and the functional operation of the project as a whole.
- B. Provide products compliant with the following sections for all devices specified and as indicated on the project drawings. If substitutions are necessary or warranted, follow the substitution submittal procedure defined in the project specifications. This section shall address the product requirements for the following components.
  - 1. Wiring
  - 2. Control Valves & Actuators
  - 3. Temperature Sensors
  - 4. Occupancy Sensors
  - 5. Differential Pressure Sensors
  - 6. Current Sensing Relays
  - 7. Current Transformers
  - 8. Control Relays
  - 9. Electrical Power Meters
  - 10. Water Level Sensors
  - 11. Vibration Switches
- C. Provide the following electrical work as work of this Section, complying with requirements of Division 26 Sections.
  - 1. Control wiring between field-installed controls, indicating devices, and unit control panels.
  - 2. Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated for all mechanical and controls.
  - 3. Wiring associated with annunciator and alarm panels (remote alarm panels) and connections to their associated field devices.
  - 4. All other necessary wiring for a fully complete and functional control system as specified.
- D. Refer to other Division 20 and Division 23 Sections for installation of instrument wells, valve bodies, and dampers in mechanical systems.

##### **1.3 SUBMITTALS**

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- A. General: Submit under provisions of Division 01. Provide a complete and comprehensive submittal package. Partial submittals shall not be accepted. Upon completion submit all compliance data and project record documents.
- B. Preconstruction Submittals.
  - 1. Control Devices Product Data: Submit manufacturer's technical product data for each control device, panel, and accessory furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes.
    - a. Provide a list of devices in schedule form on 8½ x 11 sheets. The schedule shall be organized by columns to define all new devices to be installed as part of the IAS system installation including the location, system served, controlling unit, model number, performance data, size, range, accuracy, span, operating pressure, etc.
      - 1) Control Valves & Actuators
      - 2) Temperature Sensors
      - 3) Occupancy Sensors
      - 4) Differential Pressure Sensors
      - 5) Current Sensing Relays
      - 6) Current Transformers
      - 7) Water Service Meters
      - 8) Control Relays
      - 9) Electrical Power Meters
      - 10) Natural Gas Meters
      - 11) Water Level Sensors
      - 12) Vibration Switches
    - b. Submit detailed cut sheets indicating the features, accessories and sub-assemblies of the following, or similar, as required:
    - c. All ancillary devices including temperature sensors, flow sensors, and the like, including thermal wells where necessary
    - d. Pressure gauges, thermometers and indicating devices where shown on the drawings
    - e. Transformers required for control devices
    - f. Relays
    - g. Electrical enclosures and back-plates
    - h. Wire for DLN, FAC LAN, and all sensors and actuators
    - i. FAC LAN Hub(s), Switches, and Routers
    - j. DLN Repeaters
    - k. Gateway and interface devices
      - 13) Schedule of control dampers including leakage and flow characteristics.
      - 14) Schedule of control valves including pressure drop, Cv, leakage, and flow characteristics.

#### 1.4 REFERENCED STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within all references.

## PART 2 - PRODUCTS

### 2.1 GENERAL

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- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- B. All control devices shall be electronic using DDC control unless specified on the drawings.
- C. Provide electronic and electric control products in sizes and capacities indicated, consisting of valves, dampers, controllers, sensors, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

## 2.2 MATERIALS AND EQUIPMENT

- A. Communication Wiring: All wiring shall be in accordance with the latest edition of the National Electrical Code and Division 26. Communication wiring shall be provided in a customized color jacketing material. Material color shall be as submitted and approved by Owner. Each end of the wire, originating and terminating end shall have a unique label identifying the purpose of the wire. An example of the required submittal and the application is provided below:

Purpose	Function	Color
Primary Communications DLN	Field Device Communication	Red / Pink
Spare Primary Communication DLN	Field Device Communication	Yellow
Secondary Communications DLN	Equipment Integration	Orange
Spare Secondary Communication DLN	Equipment Integration	Purple
FACLAN	Enterprise Network	Dark Blue
Spare FACLAN	Enterprise Network	Green
Analog Points	I/O Wiring	White
Digital Points	I/O Wiring	White / Black Stripe
Emergency Power	Control power	Yellow / Black Stripe
24VAC	Control power	Gray

- B. Device Level Network (DLN): Contractor shall supply all communication wiring between JACE Controllers, Routers, Gateways, AAC's, ASC's, RIO's and local and remote peripherals. Integrate with existing communication infrastructure as illustrated on the design drawings.

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- C. Local Supervisory Facility LAN (FAC LAN): For any portions of the FAC LAN required under this Section of the Specification, Contractor shall follow the requirements of Division 26 specifications. Network shall be run with no splices and separate from any wiring over thirty (30) volts.
- D. Primary (Master) and Secondary (Slave or Spare) Controller DLNs: Communication wiring shall be individually 100 percent shielded per manufacturer's recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated. DLN wiring shall be run with no splices and separate from any wiring over thirty (30) volts. Shield shall be terminated and wiring shall be grounded as recommended by building controller manufacturer.
- E. Signal Wiring: Contractor shall run all signal wiring in accordance with the latest edition of the National Electrical Code and Division 26.
- F. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100 percent shielded pair, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.
- G. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.
- H. Low Voltage Analog Output Wiring: Contractor shall run all low voltage control wiring in accordance with the latest edition of the National Electrical Code and Division 26.
- I. Low voltage control wiring shall be twisted pair, 100 percent shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices and separated from any wiring above thirty (30) volts.
- J. Control Panels: Refer to section 25 14 00.

## 2.3 STANDARD SERVICE CONTROL VALVES

- A. General:
  - 1. Provide factory fabricated control valves of type, body material and pressure class indicated.
  - 2. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system.
  - 3. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve.
  - 4. Control valves shall be equipped with heavy-duty actuators, and with proper close-off rating for each individual application.
  - 5. Minimum close-off rating shall be as scheduled and adequate for each application, and shall generally be considered at dead head rating of the pump.
- B. Globe Valves:
  - 1. Application: Two position and modulating control valves up to 8" for chilled water, heating hot water, and condenser water applications. Modulating control valves for air handling unit chilled and hot water coils
  - 2. Valve Sizing: 3-6 psig pressure drop at design flow rate.
  - 3. Single Seated (Two-way) Valves: Valves shall have equal-percentage characteristic for typical heat exchanger service and linear characteristic for building loop connections to campus systems unless otherwise scheduled on the

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drawings. Valves shall have cage-type trim, providing seating and guiding surfaces for plug on 'top-and-bottom' guided plugs.

- C. Double Seated (Three-way) Valves: Valves shall have linear characteristics. Valves shall be balanced-plug type, with cage-type trim providing seating and guiding surfaces on top-and-bottom' guided plugs.
1. Temperature Rating: 25 degrees F minimum, 250 degrees F maximum
  2. Body: Bronze, screwed, 250 psi maximum working pressure for ½ inch to 2 inch; Cast iron, flanged, 125 psi maximum working pressure for 2-1/2 inches and larger.
  3. Valve Trim: Bronze; Stem: Polished stainless steel
  4. Packing: Spring Loaded Teflon or Synthetic Elastomer U-cups, self-adjusting
  5. Plug: Brass, bronze or stainless steel, Seat: Brass
  6. Disc: Replaceable composition or stainless steel filled PTFE
  7. Ambient Operating Temperature Limits: -10 to 150 degrees F (-12.2 to 66 degrees C)
  8. Acceptable Manufacturers: Subject to compliance with requirements, approved manufacturers are as follows:
    - a. Johnson Controls
    - b. Honeywell
    - c. Warren
    - d. Belimo
    - e. Approved equal
- D. Ball Valves:
1. Application: Modulating control valves up to 2" for terminal unit and fan coil unit heating hot water and chilled water valves.
  2. Body: Brass or bronze; one-, two-, or three-piece design; threaded ends
  3. Seat: Reinforced Teflon
  4. Ball: Stainless steel
  5. Port: Standard or 'V' style
  6. Stem: Stainless steel, blow-out proof design, extended to match thickness of insulation
  7. Cold Service Pressure: 600 psi WOG
  8. Acceptable Manufacturers: Subject to compliance with requirements, approved manufacturers are as follows:
    - a. Johnson Controls
    - b. Honeywell
    - c. Warren
    - d. Belimo
    - e. Approved equal
- E. Butterfly Type: To be used for two-position control and modulating applications above 8" only, unless prior approval is obtained from Owner.
1. Body: Extended neck epoxy coated cast or ductile iron with full lug pattern, ANSI Class 125 or 250 bolt pattern to match specified flanges
  2. Seat: EPDM, except in loop bypass applications where seat shall be metal to metal
  3. Disc: Bronze or stainless steel, pinned or mechanically locked to shaft
  4. Bearings: Bronze or stainless steel
  5. Shaft: 416 stainless steel
  6. Cold Service Pressure: 175 psi
  7. Close Off: Bubble-tight shutoff to 150 psi
  8. Operation: Valve and actuator operation shall be smooth both seating and unseating. Should more than 2 psi deadband be required to seat/unseat the valve, valve shall be replaced at no cost to the Owner.



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9. Acceptable Manufacturers: Subject to compliance with requirements, approved manufacturers are as follows:
  - a. Keystone
  - b. Honeywell
  - c. Bray Series 31
  - d. Dezurik BGS
  - e. Approved equal

## 2.4 ACTUATORS

- A. General: Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied. Manual override shall allow the user to disengage the valve/damper from the actuators motor for manual operation. Large valve actuators shall provide fly wheel for manual operation.
- B. Actuators General Requirements:
  1. Ambient Operating Temperature Limits: -10 to 150 degrees F (-12.2 to 66 degrees C).
- C. Two Position Electric Actuators: Line voltage (120 volt, 24 volt) with spring return. Provide end switches as required.
- D. Electronic Actuators: Provide actuators with spring return for two-position (24 volt), 0-5 VDC, 0-10 VDC, 2-10VDC, 4-20 mA, as required. Actuators shall travel full stroke in less than 90 seconds. Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed. Provide stroke indicator. Actuators shall have positive positioning circuit. Where two actuators are required in parallel or in sequence provide an auxiliary actuator driver. Actuators shall have current limiting motor protection. Actuators shall have manual override where indicated. Modulating actuators for valves shall have minimum range of 40 to 1.
- E. Close-Off Pressure: Provide the minimum torque required, and spring return for failsafe positioning (unless otherwise specifically indicated) sized for required close-off pressure. Required close-off pressure for two-way water valve applications shall be the shutoff head of associated pump. Required close-off rating of air damper applications shall be shutoff pressure of associated fan, plus 10 percent.
- F. Manufacturer shall provide a 2 year unconditional warranty from date of substantial completion.
- G. Sound levels for VAV actuators shall not exceed 45 dB.
- H. Electronic overload protection shall protect actuator motor from damage. If damper jams actuator shall not burn-out. Internal end switch actuators are not acceptable.
- I. Subject to compliance with requirements, approved manufacturers are as follows:
  - a. Distech
  - b. Belimo
  - c. Johnson Controls
  - d. Honeywell
  - e. Approved equal
- J. Electric Control Valve Actuator General Requirements



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1. Gear Train: Motor output shall be directed to a self-locking gear drive mechanism. Gears shall be rated for torque input exceeding motor locked rotor torque.
  2. Wiring: Power and control wiring shall be wired to a terminal strip in the actuator enclosure.
  3. Failsafe Positioning: Actuators shall be spring return type for failsafe positioning.
  4. Enclosure: Actuator enclosure shall be a NEMA 4 epoxy coated metal enclosure, and shall have a minimum of two threaded conduit entries.
  5. Limit Switches: Travel limit switches shall be UL approved. Switches shall limit actuator in both open and closed positions.
  6. Mechanical Travel Stops: The actuator shall include mechanical travel stops of stainless steel construction to limit actuator to specific degrees of rotation.
  7. Manual Override: Actuators shall have manual actuator override to allow operation of the valve when power is off. For valves 4 inches and smaller the override may be a removable wrench or lever or geared handwheel type. For larger valves, the override shall be a fixed geared handwheel type. An automatic power cut-off switch shall be provided to disconnect power from the motor when the handwheel is engaged for manual operation.
  8. Valve Position Indicator: A valve position indicator with arrow and open and closed position marks shall be provided to indicate valve position.
  9. Torque Limit Switches: Provide torque limit switches to interrupt motor power when torque limit is exceeded in either direction of rotation.
  10. Position Controller: For valves used for modulating control, provide an electronic positioner capable of accepting 4-20 mA, 0-10 VDC, 2-10 VDC, and 135 Ohm potentiometer.
  11. Ambient Conditions: Actuator shall be designed for operation from -140 to 150 degrees F ambient with 0 to 100 percent relative humidity.
  12. Field selectable direction with field adjustable zero span.
- K. Electric Control Valves Actuators 4 inches and larger:
1. The valve actuator shall consist of a permanent split capacitor, reversible type electric motor which drives a compound epicycle gear. The electric actuator shall have visual mechanical position indication, readable from a distance of 25 feet, showing output shaft and valve position. Unit shall be mounting directly to the valves without brackets and adapters, or readily adapted to suit all other types of quarter-turn valves.
  2. The actuator shall have an integral terminal strip, which, through conduit entries, will ensure simple wiring to power supplies. Cable entries shall have UL recommended gland stops within the NPT hole to prevent glands from being screwed in too far and damaging cable.
  3. The actuator shall be constructed to withstand high shock and vibrations without operations failure. The actuator cover shall have captive bolts to eliminate loss of bolts when removing the cover from the base. One copy of the wiring diagram shall be provided with the actuator.
  4. The actuator shall have a self-locking gear train which is permanently lubricated at the factory. The gearing shall be run on ball and needle bearings. Actuators with 620 in-lb or more output torque shall have two adjustable factory calibrated mechanical torque limit switches of the single-pole, double-throw type. The motor shall be fitted with thermal overload protection. Motor rotor shaft shall run in ball bearings at each end of motor.
  5. For intermittent on/off service, the actuator shall be rated at a 20% duty cycle (i.e., 12 minutes extended duty in every hour, or alternatively; one complete cycle every 2 minutes). For more frequent cycling and modulating service, an actuator shall be rated for continuous duty. The actuator rated for continuous duty shall be capable of operating 100% of the time at an ambient temperature of 105°F.
  6. The actuator shall have an integral self-locking gear train. Motor brakes shall not

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- be required to maintain desired valve position. Levers or latches shall not be required to engage or disengage the manual override. Mechanical travel stops, adjustable to 15° in each direction of 90° rotation shall be standard, as well as two adjustable travel limit switches with electrically isolated contacts. Additional adjustable switches shall be available as an option.
7. Single Phase Motor: The motor shall have Class B insulation capable of withstanding locked-rotor for 25 seconds without overheating. Wiring shall also be Class B insulation. An auto-reset thermal cut-out protector shall be embedded in the motor windings to limit heat rise to 175°F in a 105°F ambient. All motors shall be capable of being replaced by simply disconnecting the wires and then removing mounting bolts. Disassembly of gears shall not be required to remove the motor.
  8. Motor: Suitable for 120 or 240 volt single-phase power supply. Insulation shall be NEMA Class F or better. Motors shall have inherent overload protection.
  9. Materials of Construction: The electric actuator shall have a pressure die-cast, hard anodized aluminum base and cover. The compound gear shall be made of die-cast, hard anodized aluminum or steel. An alloy steel worm gear shall be provided for manual override and torque limiting. Bearings for gears shall be of the ball and needle type; bronze bearings shall be used on the shafting parts.
  10. Torque: Size for minimum 150% of required duty.
  11. Potentiometer for providing continuous feedback of actuator position at the controller (for valves specified position feedback).

## 2.5 GENERAL FIELD DEVICES

- A. Provide field devices for input and output of digital (binary) and analog signals into controllers (RIO, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers and as required for proper operation in the system.
- B. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.
- C. Field devices specified herein are generally 'two-wire' type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, is not designed to work with 'two-wire' type transmitters, if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide 'four-wire' type transmitters and necessary regulated DC power supply or 120 VAC power supply, as required.
- D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy and repeatability equal to, or better than, the accuracy and repeatability listed for respective field devices.
- E. Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis.
- F. Temperature transmitters shall be sized and constructed to be compatible with the medium to be monitored. Transmitters shall be equipped with a linearization circuit to compensate for non-linearity of the sensor and bridge to provide a true linear output signal.

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- G. Sensors used in energy or process calculations shall be accurate to  $\pm 0.10^{\circ}\text{C}$  over the process temperature range. Submit a manufacturer's calibration report indicating that the calibration certification is traceable to the National Bureau of Standards (NBS) Calibration Report Nos. 209527/222173.
- H. The following accuracy's are required and include errors associated with the sensor, lead wire and A to D conversion.

Point Type	Accuracy
Outside Air	0.2 °C
Chilled/Hot Water	0.2 °C
Room Temperature	0.2 °C
Duct Temperature	0.2 °C
Sensors Used in Energy	
Water (BTU) or Process	+/-1%
Calculations	

## 2.6 TEMPERATURE SENSORS (TS)

- A. Sensor range: When matched with A/D converter of AAC/ASC, or SD, sensor range shall provide a resolution of no worse than 0.3 degrees F (0.16 degrees C) (unless noted otherwise). Where thermistors are used, the stability shall be better than 0.25 degrees F over five (5) years.
- B. Matched Sensors: The following applications shall require matched sensors:
1. Hydronic Temperature Difference Calculations: Provide matched supply and return temperature sensors where the pair is used for calculating temperature difference for use in load calculations or sequencing such as across chillers and plants. Sensing element shall be platinum RTD guaranteeing an accuracy of +/- 0.5 percent of span plus 0.1 degrees C.
- C. Room Temperature Sensor: Shall be an element contained within a ventilated cover, suitable for wall mounting, unless noted otherwise. Provide insulated base. The following sensing elements are acceptable:
1. Acceptable Manufacturers
    - a. Distech Allure UNITOUCH is listed as a sole source product in the District's design and construction standards. Alternate products will not be considered.
  2. Sensing element shall be thermistor (10K Ohm, Type II), +/- 0.1 degrees F accuracy at calibration point (10,000 Ohms @ 77 °F).
  3. Sensing element shall be mounted in a plastic enclosure
  4. Operating Temperature Range: -40 to 302 °F (-40 to 150 °C)
  5. Operating Humidity Range: 0 to 90% RH non-condensing
  6. Provide setpoint adjustment. The setpoint adjustment shall be a warmer/cooler indication that shall be scalable or limited via the IAS.
  7. Provide an occupancy override button on the room sensor enclosure. This shall be a momentary contact closure.
  8. Provide current temperature setpoint and measurement indication via a backlit LCD or LED readout.
  9. Provide unit/zone heating and cooling status via the backlit LCD or LED readout.
  10. Submit sensor to Architect for aesthetic and finish approval prior to installation.
  11. Provide an electrical junction box behind RTS and route all thermostat/low voltage cable within walls in rigid conduit.

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- D. Standard Single-Point Duct Temperature Sensor: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated. Sensor probe shall be 316 stainless steel.
1. Sensing element shall be thermistor (10K Ohm, Type II), +/- 0.1 degrees F accuracy at calibration point (10,000 Ohms @ 77 °F).
  2. Sensing element shall be encased in 4" or 8" stainless steel probe
  3. Operating Temperature Range: -40 to 302 °F (-40 to 150 °C)
  4. Operating Humidity Range: 0 to 90% RH non-condensing
  5. Sensor stability +/- 0.13 °C Duct mount sensors shall mount in a hand box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement. A neoprene grommet (sealtite fitting and mounting plate) shall be used on the sensor assembly to prevent air leaks.
  6. For outdoor air duct applications, use a weatherproof mounting box with weatherproof cover and gasket.
- E. Standard Averaging Duct Temperature Sensor: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three square feet of cooling coil/duct face area, or as recommended by manufacturer. Temperature range as required for resolution indicated.
1. Sensing element shall be thermistor (10K Ohm, Type II), +/- 0.2 degrees F accuracy at calibration point (10,000 Ohms @ 77 °F).
  2. Sensing element shall be encased in 8' (4 sensing points), 12' (4 sensing points) or 24' (9 sensing points) long bendable copper sheath
  3. Operating Temperature Range: -40 to 302 °F (-40 to 150 °C)
  4. Operating Humidity Range: 0 to 90% RH non-condensing
  5. Sensor stability +/- 0.13 °C
  6. Provide capillary supports at the sides of the duct / coil to support sensing elements
  7. Averaging Sensor shall traverse the width of the duct.
- F. Liquid immersion temperature sensor shall include brass thermowell, sensor and connection head for wiring connections. Temperature range shall be as required for resolution of 0.15 degrees F.
1. Sensing element (chilled water/glycol systems) shall be platinum RTD +/- 0.2 degrees C measured at 0 degrees C.
  2. Thermowells
    - a. When thermowells are required, the sensor and well shall be supplied as a complete assembly including well head and greenfield fitting, except where wells are to be installed under separate contract.
    - 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 12.7 mm NPT saddle and allow easy access to the sensor for repair or replacement.
    - d. Thermowells shall be constructed of the following materials:
      - 1) Chilled and Hot Water; brass.
      - 2) Steam; 316 stainless steel.
      - 3) Brine (salt solutions): marine grade stainless steel.
- G. Outside Air Sensors shall consist of a sensor, sun shield, utility box, and watertight gasket to prevent water seepage. Temperature range shall be as require for resolution indicated in this Section.
1. Sensing element shall be thermistor (10K Ohm, Type II), +/- 0.2 degrees F accuracy at 0 to 70 °F.

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2. Sensing element shall be encased in a weather proof enclosure which shall be designed to withstand the environmental conditions it will be exposed.
3. Provide a solar shield
4. Operating Temperature Range: -40 to 302 °F (-40 to 150 °C)
5. Operating Humidity Range: 0 to 90% RH non-condensing
6. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate surrounding the sensor element.
7. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

## 2.7 DIFFERENTIAL PRESSURE TRANSMITTERS (DP)

- A. General DP performance requirements
  1. 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.
  2. Pressure transmitters shall provide the option to transmit a 0 to 5V dc, 0 to 10V dc, or 4 to 20 mA output signal.
  3. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device and shall be supplied with shutoff and bleed valves in the high and low sensing pick-up lines (3 valve manifolds).
  4. Provide a minimum of a NEMA 1 housing for the transmitter. Locate transmitters in accessible local control panels wherever possible. Provide tubing with rubber or neoprene grommet from panel to expose room conditions when necessary.
  5. Low air pressure, differential pressure transmitters used for room pressurization control (i.e. laboratories, OR's clean rooms, etc.) shall be equipped with a LED display indicating the transmitter output signal.
  6. Duct sensing pressure applications where the velocity exceeds 1500 fpm shall utilize a static pressure traverse probes.
- B. Liquid, Steam and Gas :
  1. General: Two-wire smart DP cell type transmitter, 4-20 mA or 1-5 VDC linear output, adjustable span and zero, stainless steel wetted parts.
  2. Ambient Limits: -40 to 175 degrees F (-40 to 121 degrees C), 0 to 100% RH.
  3. Process Limits: -40 to 400 degrees F (-40 to 205 degrees C).
  4. Accuracy: Less than 0.1 percent.
  5. Output Damping: Time constant user selectable from 0 to 36 seconds.
  6. Non-interactive zero and span adjustments adjustable from the outside cover.
  7. Vibration Effect: Less than +/- 0.1 percent of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
  8. Electrical Enclosure: NEMA 4, 4X, 7, 9.
  9. Approvals: FM, CSA.
  10. Acceptable Manufacturers:
    - a. Setra
    - b. Honeywell
    - c. Approved equal

## 2.8 CURRENT SENSING RELAYS (CSR)

- A. Current Sensing switch shall be self-powered with solid-state circuitry and a dry contact output. Current sensing switch shall accept over current up to twice its trip range. Clamp-On Design Current Operated Switch (for Constant Speed Motor Status Indication):
  1. Range: 2.5 to 135 amps
  2. Trip Point: Adjustable
  3. Switch: Solid state, normally open, 1.0A @ 30VAC/DC
  4. Lower Frequency Limit: 6 Hz

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5. Trip Indication: LED
  6. Approvals: UL, CSA
  7. Max. Cable Size: 350 MCM
  8. Acceptable Manufacturers:
    - a. Veris Industries H-908
    - b. Approved equal
- B. Clamp-on Wire Through Current Switch (CS/CR) (for Constant Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 VAC resistive, 3A @ 240 VAC inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A).
1. Acceptable Manufacturers:
    - a. Veris Industries, Inc. Model # H938
    - b. RE Technologies RCS 1150
    - c. Approved equal
  2. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing similar with override switch to Kele RIBX.
  3. Clamp-On Design Current Operated Switch for Variable Speed Motor Status Indication:
  4. Range: 3.5 to 135 Amps
  5. Trip Point: Self-calibrating based on VA memory associated with frequency to detect loss of belt with subsequent increase of control output to 60 Hz
  6. Switch: Solid state, normally open, 0.1A @ 30VAC/DC
  7. Frequency Range: 35 to 75 Hz
  8. Trip Indication: LED
  9. Approvals: UL, CSA
  10. Max. Cable Size: 350 MCM
  11. Acceptable Manufacturers:
    - a. Veris Industries, Inc. H-904
    - b. Approved equal
- C. Clamp-On Wire Through Current Switch (CS/CR) (for Variable Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 VAC resistive, 3A @ 240 VAC inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A).
1. Acceptable manufacturers:
    - a. Veris Industries, Inc., Model # H934
    - b. Approved equal

## 2.9 CURRENT TRANSFORMERS (CT)

- A. The current transformers shall be designed to be installed or removed without dismantling the primary bus or cables.
- 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:  $\pm .2\%$  at 5.0 to 25.0 VA accuracy class with U.P.F. burden
  4. Range <1-10 Amps minimum, 20-200 amps> maximum
  5. Trip Point adjustable
  6. Output 0-5 VDC
  7. Provide a disconnect switch for each current transformer



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8. Protection: 250 A max current
9. Acceptable Manufacturers:
  - a. Ohio, Semitronics Technologies Inc.
  - b. Triad Technologies
  - c. EMON
  - d. Hawkeye
  - e. Approved equal

## 2.10 WATER SERVICE METERS

- A. General Requirements:
  1. Refer to plumbing plans and Division 22 specifications.

## 2.11 ELECTRIC CONTROL COMPONENTS

- A. Limit Switches (LS): Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley or approved equal.
- B. Control Relays General:
  1. Relays other than those associated with digital output cards 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.
  2. Solid State Relays (SSR): Input/output isolation shall be greater than 10E9 ohms with a breakdown voltage of 1500V root mean square or greater at 60 Hz. The contact life shall be 10 x 10 E6 operations or greater. The ambient temperature range of SSRs shall be -20 to +140°F. Input impedance shall not be less than 500 ohms. Relays shall be rated for the application. Operating and release time shall be for 100 milliseconds or less. Transient suppression shall be provided as an integral part of the relay.
  3. Contactors: Contactors shall be of the single coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches, or semi-permanent magnets. Contractor shall be double-break-silver-to-silver type protected by arcing contacts. The number of contacts and rating shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices.
  4. Control Relays: All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA 1 enclosure for indoor locations, NEMA 4 for outdoor locations.
  5. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:
    6. AC coil pull-in voltage range of +10 percent, -15 percent or nominal voltage.
    7. Coil sealed volt-amperes (VA) not greater than four (4) VA.
    8. Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.
    9. Pilot light indication of power-to-coil and coil retainer clips.
    10. Coil rated for 50 and 60 Hz service.
- C. Acceptable Manufacturers:
  1. Potter Brumfield, Model KRPA
  2. Approved equal
- D. Material: Gold Flash

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- E. Rating 10 amps at 120-277 VAC
- F. Provide HOA switch except in smoke control applications.
- G. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 horsepower, and 1/3 horsepower, shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC or approved equal.
- H. Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be provided with transient and surge suppression devices at the controller interface.
- I. General Purpose Power Contactors: NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA 1 enclosure. Manufacturer shall be Square 'D', Cutler-Hammer, Westinghouse, or approved equal.
- J. Control Transformers: Furnish and install control transformers as required. Control transformers shall be machine tool type, and shall be US and CSA listed. Primary and secondary sides shall have replaceable fuses in accordance with the NEC. Transformer shall be properly sized for application, and mounted in minimum NEMA 1 enclosure.
- K. Transformers shall be manufactured by <Westinghouse, Square 'D', Jefferson, or approved equal>.
- L. Electric Selector Switch (SS): Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 VAC operation. Switch shall be 800T type, as manufactured by Allen-Bradley or approved equal.

## 2.12 ELECTRICAL POWER METERS

- A. General Requirements:
- B. Meter accuracy specifications shall comply with ANSI C12.20 Class 0.2% to 0.5% accuracy at 25°C.
  - 1. Meter shall be UL certified.
  - 2. Meter accuracy shall be + 0.5% for power measurements.
  - 3. Capability to measure and record 15 minute interval data.
  - 4. Capable of monitoring of: phase voltages, phase currents, power consumption, power factor, harmonics, power quality and kVAR.
  - 5. Meter shall be capable of either BACnet or MODBUS communication
- C. Wall Mounted Power Meters
  - 1. The meter shall be UL listed and CE marked.
  - 2. Power meter shall be designed for Multifunction Electrical Measurement on 3 phase power systems.
  - 3. Meter shall support 3 element wye, 2.5 element wye, 2 element delta, 4 wire delta systems.
  - 4. The meter shall accept universal voltage input.
  - 5. Surge withstand shall conform to IEEE C37.90.1.
  - 6. The power meter shall meet IEC 62053-22 Class 2 reactive power and energy accuracy specifications.
  - 7. The power meter shall meet both ANSI C12.20 .5% and IEC 62053-22 Class .5S real power and energy accuracy specifications.
  - 8. The meter shall be user programmable for voltage range to any PT ratio.
  - 9. Meter shall accept a burden of up to .36VA per phase, Max at 600V, 0.014VA at 120 Volts.



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10. Meter shall be capable of BACnet communication
  11. The meter shall be located in a dedicated NEMA wall panel, installed flush to the wall, with a clear hinged cover allowing remote display viewing.
  12. The power meter shall perform the following measurements:
    - a. Accumulated Real Energy (kWh) for each phase and total of all phases
    - b. Accumulated Reactive Energy (kVARh) and Apparent Energy (kVAh) totals for all phases
    - c. Net Present Demand for Real (kW), Reactive (kVAR) and Apparent (kVA) Power over a user-specified interval (block or sliding window)
    - d. Maximum (Peak) Real (kW), Reactive (kVAR) and Apparent (kVA) Demand Intervals
    - e. Instantaneous Real (kW), Reactive (kVAR) and Apparent Power (kVA), by phase and in total
    - f. Current (amps) for each phase and average of all phases
    - g. Phase-to-phase voltage for each phase and average of all phase pairs
    - h. Phase-to-neutral voltage for each phase pair and average of all phases
    - i. Power factor for each phase and average of all phases
    - j. AC frequency
  13. Acceptable Manufacturers:
    - a. Veris Industries.
    - b. Approved equal
- D. Current and Potential Transformers
1. Current Transformers shall conform to the following requirements:
    - a. Insulation Class: All 600 volt and below current transformers shall be rated 10 KV BIL. Current transformers for 2400 and 4160 volt service shall be rated to 25 KV BIL.
    - b. Frequency: Nominal 60 Hz
    - c. Burden: Burden Class shall be selected for the load
    - d. Phase Angle Range: 0 to 60 degrees
    - e. Provide a multi-ratio current transformer with a top range equal to or greater than the actual load. Select a ratio for each current transformer that matches the minimum and maximum power load.
    - f. Install Potential Transformers sized for the installed service voltage. Provide a disconnect switch (fuses) or a means to isolate the meter base from the voltage source without service shut-down.
    - g. Provide a disconnecting wiring block between the current transformer and the meter. A shorting mechanism shall be built into the wiring block to allow the current transformer wiring to be changed without removing power to the transformer. The wiring block shall be located where they are accessible without the necessity of disconnecting power to the transformers. For multi-ratio current transformers, provide a shorting block from each tap to the common lead.
- E. Miscellaneous
1. Within one year after acceptance of Work, verify operation and recalibrate each meter in accordance with the manufacturer's written instructions.
  2. The installation contractor shall affix labels to each meter, using a labeling nomenclature supplied by the Owner's Representative. Label information shall correspond to meters indicated on the block diagram.

## 2.13 NATURAL GAS METERS

- A. General Requirements:
1. Refer to plumbing plans and Division 22 specifications.

## 2.14 WATER SUBMERSIBLE LEVEL SENSOR

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- A. Water level sensors shall be hermetically sealed, vibration resistant
- B. Output: 4-20 MA
- C. Accuracy: +/-0.25%
- D. Stem and float material: stainless steel
- E. Allowable temperature range: -40°F to 392°F
- F. Allowable pressure: 100psig
- G. Required Accessories:
  - 1. Submersible Level Transmitter Aneroid Bellows
  - 2. Junction Box for Aneroid Bellows and terminal strip
  - 3. Battery or power supply for 4-20ma output
- H. Install switch at recommended low water level height per manufacturer recommendation
- I. Acceptable Manufacturers:
  - 1. Pro-sense SLT
  - 2. Approved equal

## **2.15 VIBRATION SWITCH**

- A. Spring loaded, magnetically coupled, requiring no external power supply
- B. Relay rated for output to external dry contact
- C. Adjustable trip setting
- D. Install switch at recommended low water level height per manufacturer recommendation
  - 1. Acceptable Manufacturers:
    - a. Marley
    - b. Approved equal

## **2.16 NAMEPLATES**

- A. Provide engraved phenolic or micarta nameplates for all field devices furnished. Nameplates shall be 1/8 inch thick, black, with white center core, and shall be minimum 1 inch x 3 inch, with minimum 1/4 inch high block lettering. Nameplates for devices smaller than 1 inch x 3 inch shall be attached to adjacent surface.
- B. Each nameplate shall identify the function for each device.

## **2.17 TESTING EQUIPMENT**

- A. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be

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at least twice as accurate as respective field device (e.g., if field device is +/- 0.5 percent accurate, test equipment shall be +/- 0.25 percent accurate over same range).

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Owner.

### **3.2 INSTALLATION OF CONTROL SYSTEMS**

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. Installation shall be in accordance with manufacturer's published recommendations.
- C. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings. Install electrical components and use electrical products complying with requirements of the latest edition of the National Electrical Code and all local codes.
- D. Control Valves: Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.
- E. Averaging Temperature Sensors: Cover no more than three square feet per linear foot of sensor length except where indicated. Generally, where flow is sufficiently homogeneous/adequately mixed at sensing location, consult Engineer for requirements.
- F. Airflow Measuring Stations: Install per manufacturer's recommendations in an unobstructed straight length of duct (except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFM station manufacturer.
- G. Fluid Flow Sensors: Install per manufacturer's recommendations in an unobstructed straight length of pipe.
- H. Relative Humidity Sensors: Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.
- I. Water Differential Pressure Transmitters: Provide valve bypass arrangement to protect against over pressure damaging the transmitter.
- J. Pipe Surface Mount Temperature Sensors: Install with thermally conductive paste at pipe contact point. Where sensor is to be installed on an insulated pipe Contractor shall neatly cut insulation install sensor, repair or replace insulation and vapor barrier and adequately seal vapor barrier.
- K. Flow Switches: Where possible, install in a straight run of pipe at least 15 diameters in

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length to minimize false indications.

- L. Current Switches for Motor Status Monitoring: Adjust so that setpoint is below minimum operating current and above motor no load current.
- M. Supply Duct Pressure Transmitters:
  - 1. General: Install pressure tips with at least four (4) 'round equivalent' duct diameters of straight duct with no takeoffs upstream. Install static pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions. Locate the transmitter at an accessible location to facilitate calibration.
  - 2. VAV System 'Down-Duct' Transmitters: Locate pressure tips approximately 2/3 of the hydraulic distance to the most remote terminal in the air system or as directed by the engineer and/or owner's representative. Refer to IAS and mechanical drawings for more detail.
- N. Cutting and Patching Insulation: Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.
- O. Wiring:
  - 1. Install control wiring and electrical work in accordance with National Electrical codes. In addition to the requirements specified herein, the wiring installation shall meet the requirements of EIA/TIA Standard 568, Commercial Building Standard for telecommunication pathways and spaces.
  - 2. Wiring Inside Rigid Conduit: Within walls, in exposed areas, and areas exposed to weather. Minimum conduit size 3/4".
  - 3. Plenum Rated Wiring: Concealed areas above ceilings. Coordinate with electrical contractor. Support final connection wiring in accordance to National Electric Code and at every four feet. Diagonal installation shall not be accepted. Provide sleeves for wall penetrations.
- P. Water Level Switch
  - 1. Coordinate recommended low level alarm height and recommended mounting with cooling tower manufacturer.
  - 2. Do not alter cooling tower without express consent of owner. Work shall not alter or void any warranty.

**END OF SECTION 25 11 00**

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## SECTION 25 14 00 IAS NETWORK CONTROLLERS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. This section defines the Basic Materials and Methods used in the installation of the Integrated Automation System (IAS).
- B. Related Specifications:
  - 1. Section 250600 – Network Scheduling Software for HVAC
  - 2. Section 250000 – Integrated Automation Systems (IAS) For HVAC
  - 3. Section 250800 – Fault Detection and Diagnostics Software for HVAC
  - 4. Section 251500 – IAS Software and Programming Tools for HVAC

#### 1.2 SUMMARY

- A. Section includes:
  - 1. Java Application Control Engine (JACE).
  - 2. BACnet IP Enabled Field Level Controller (B-BC)
  - 3. BACnet Application Specific Controller (B-ASC).
  - 4. BACnet Advance Application Controller (B-AAC).
  - 5. Intelligent Sensors and Actuators (ISA).
- B. The IAS shall be comprised of Niagara 4 JACE Network Controllers added to the existing IAS infrastructure.
- C. Provide BTL certified products that communicate on MS/TP channels to meet the functional specifications of this Division and the dedicated product functional specifications and profiles specified in other Sections of this Specification.
- D. The number of Niagara 4 JACE network controllers required is dependent on the type and quantity of devices installed. It is the responsibility of the Contractor to determine the quantity and type of devices and to properly install the correct number (increase if required) of network controllers from the designed minimum shown on the IAS documents. The Contractor shall confirm the designed network load and architecture with the capabilities of the selected Network Controller. If network communications issues arise as a result of a limited Network Controller resource count the Contractor shall furnish, install, and implement additional Network Controllers to reduce the network traffic on each Network Controller's Local Operating Network to less than 50% of maximum network bandwidth or 60% of the available JACE system resource count.
- E. Repeaters can be utilized to extend the Device Level Network beyond the 4,000 foot limitation provided neither the device count limitation, 50% bandwidth limitation nor 60% of the available JACE system resource count is exceeded. Repeaters can also be utilized to improve communication within free topology networks.
- F. The Niagara 4 Supervisor Server shall provide global supervisory control functions over the JACE controllers. The JACE controllers shall provide global supervisory control functions over the control devices that are connected to each network controller. The JACE controller execute application control programs to provide:
  - 1. Calendar functions
  - 2. Scheduling

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3. Trending
  - a. Alarm monitoring and routing (locally and to Web Server)
4. Time synchronization
5. Integration of BACnet®IP (client), BACnet® MSTP, Siemens P1 and P2, Modbus®, OPC controller data, and others as required.
6. Connectivity for Network Management and programming functions for all BACnet and Siemens Apogee based devices.
7. Energy management functions
8. Control functions

### 1.3 SUBMITTALS

- A. General: Submit under provisions of Division 01. Provide a complete and comprehensive submittal package. Partial submittals shall not be accepted. Upon completion submit all compliance data and project record documents.
- B. Preconstruction Submittals.
  1. Network Controller Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, and finishes for materials for each type of controller indicated. Submit documentation indicating BTL compliance and include Protocol Implementation Conformance (PIC) Statements. Submit Niagara4 Compatibility Statements (NiCS) for each submitted
    - a. Niagara 4 JACE Network Controllers
    - b. Niagara 4 JACE Network Expansion Modules
    - c. Niagara 4 JACE Input/Output Point Modules
    - d. BACnet Building Controllers (B-BC's)
    - e. BACnet Application Specific Controllers (B-ASC's)
    - f. BACnet Advanced Application Controllers (B-AAC's)
    - g. Interface Panels
    - h. Network Management Equipment (Routers, Protocol Analyzers, etc.)
  2. 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.
    - a. Sheets shall be consecutively numbered. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.
    - b. Table of Contents listing sheet titles and sheet numbers.
    - c. Legend and list of abbreviations
    - d. Controller Panel Diagrams: Provide a panel schematic for each Building Network Controller that depicts the layout of the components within the panel. Include a Bill of Materials listing all of the components installed in the panel. In addition, the schematic shall identify the following pieces of information:
      - 1) Naming, Location and Addressing information of the Building Network Controller, including the following:
        - a) Computer Name
        - b) Object Name
        - c) Location of the Building Network Controller Panel including room numbers or any other points of reference that may be useful in identifying the location of the controller.
        - d) IP Address
      - 3) The source of 120VAC power, including the electrical panel name and circuit number.
      - 4) The type of media and any interstitial devices used for connection of the Building Network Controller to the MCCCCD

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#### Ethernet Network.

- e. DDC System Architecture: Provide a schematic showing the architecture of the DDC system's entire Building-Level Network that identifies all Building Network Controllers, JACE panels, integrated Digital Controllers, integrated Equipment Control Devices (such as VFDs, factory chiller control panels, etc.), repeaters, Operator Workstations (if required by contract documents), and LAN device including fiber optic media, converters, DSL modems, routers, hubs, bridges, and switches. Each Digital Controller, Equipment Controller, and Building Network Controller shall be identified on the schematic using the object name associated with the controller as it appears in the database. Indicate the communication protocol and physical media to be used at each level.
  - a. Schematic flow diagrams showing the systems for fans, pumps, coils, dampers, valves, and control devices. Indicate the existing point names on the schematic diagrams.
  - b. Wiring diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring. Indicate LAN/BACnet and Gateway connections.
  - c. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
  - d. A floor plan indicating the actual location of room temperature sensors, carbon dioxide sensors, and occupancy sensors for coordination with furniture layout.
  - e. A floor plan indicating location of concealed duct static pressure sensors used for controlling air moving equipment.
  - f. Written description of sequence of operation. Provide all applicable data related to optimization of energy efficiency. The Engineer of Record's sequence of operations shall be incorporated into the Shop Drawing sequences. At a minimum, include all software objects, setpoint limits, alarm conditions, alarm priorities, and time delays.
  - g. Schedule of VAV/CAV boxes identifying the name and number of all rooms served by the box, system name of the controller, associated air handling unit name, minimum airflow setpoint, and maximum airflow setpoint.
3. Test Plan for Contractor Field Tests
  - a. For every Network Building Controller and Digital Controller provide a Field Test Checkout Sheet. All data that can be filled out on each checkout sheet prior to conducting the test, shall be provided on each sheet.
  - b. Include the intended test procedure, the expected response, and the pass/fail criteria for every component tested.

#### B. Construction Submittals

1. Field Test Results: Provide documented results of the testing. The report shall include written responses and documentation of actions made to correct the deficiencies identified in the Field Test Punch List. The contents of the report shall incorporate any changes, modifications, or revisions made to the IAS system and the documentation associated with it, and shall reflect the "as-built" condition of the system.
2. JACE Station Resource Report: After approval of the functional performance testing, the contractor shall submit a report indicating the following performance metrics of each JACE network controller installed or modified by the project. These metrics shall be taken during a heavily loaded network time between 10am and 3pm on a normally occupied weekday.
  - a. Station Resource Count, including resource counts associated with each child object.
  - b. CPU Utilization: provide a report of the average idle time of the JACE network controller. If the average idle time is less than 70%, adjust network tuning policies



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such as cycle times, execution frequencies, and polling frequencies to bring idle times above 70%.

c. Available Flash Space for each NFSG

C. Closeout Submittals

1. As-Built DDC Shop Drawings:
2. Provide a complete laminated set of as-built DDC drawings that shall be permanently affixed in the Building Network Controller panel. In addition, each Digital Controller panel shall include copies of the laminated as-built DDC drawings that pertain to that system (including the Control System Schematics, Digital Controller Wiring Diagrams, Table of I/O Points, Component Wiring Diagrams, and if applicable the Valve Schedule). All drawings in a panel should be bound together and hung within the panel in a manner that prohibits their removal.
3. Provide record copies of product data and control Shop Drawings updated to reflect the final installed condition.
4. Provide as-built network architecture. Drawings showing all nodes including a description field with specific controller identification, description and location information.
5. Record copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, logical address and drawing reference number.
6. Provide record riser diagram showing the location of all controllers.
7. Maintain Project record documents throughout the Warranty Period and submit final documents at the end of the Warranty Period.

## 1.2 REFERENCED STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within all references.

## 1.3 QUALITY ASSURANCE

- A. Utilize the Niagara 4 Framework®
- B. All DDC controllers shall conform to the Interoperability requirements outlined in the BACnet® Testing Laboratory Guidelines. All BACnet® products shall be BTL certified prior to delivery of submittals to the Owner for review.
- C. Utilize standard PC components for all assemblies. Custom hardware, operating system, and utility software are not acceptable.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, Federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.



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## 2.2 STAND-ALONE FUNCTIONALITY

- A. The Contractor shall furnish and install single controllers with the physical and software resource count for standalone operation of each piece of equipment. The sequence of operation and required points for control shall reside on a single controller. Remote I/O modules (via a field wired communications bus) are not acceptable for points required to achieve the sequence of operation unless otherwise specified. Expansion I/O modules plugged directly into the controller may be utilized for expansion.
- B. Remote I/O modules shall be permitted for monitoring points and data acquisition.
- C. Where a manufacturer does not have a single controller with a large enough physical point or software point count and direct connected I/O expansion modules ~~will~~ do not meet the requirement, the following must take place at the Contractor's discretion.
- D. A second controller or I/O module may be used by establishing a secondary Sub LAN off the primary master controller housing all programming pertaining to the sequence of operation. The sub LAN could be a feature of the controller or created by means of a Router. The operation of the I/O or slave controller must not be affected by the loss of communications of the main bus.
- E. The SI Contractor has the option to provide a comparable BTL controller from another manufacturer / vendor, which can meet the resource requirements of the equipment.
- F. The following configurations are considered unacceptable with reference to a controller's standalone functionality:
- G. I/O point expansion devices connected to the main controller board via communication wiring that could be interrupted if the primary communication network is compromised (broken or shorted).
- H. Multiple controllers enclosed in the same control panel connected via communication wiring to accomplish the point requirement.

## 2.3 JACE NETWORK CONTROLLERS (NC)

- A. Acceptable Manufacturers- Subject to compliance with requirements, approved manufacturers are as follows:
  - 1. The Distech EC-BOS line of Niagara 4 JACE 8000 is listed as a sole-source product in the District's design and construction standards. Alternate products will not be considered.
- B. The Niagara 4 JACE 8000 network controller must provide the following hardware features as a minimum:
  - 1. TI AM3352 @ 1GHz
  - 2. 1GB RAM
  - 3. 4GB flash total storage / 2GB user storage
  - 4. Embedded Wi-Fi (Client or WAP)
  - 5. High-speed field bus expansion
  - 6. (2) Isolated RS 485
  - 7. (2) 10/100MB Ethernet ports
- C. The network controller must be capable of operation over a temperature range of -20°C to 60°C.

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- D. General Requirements: The Network Controllers shall be Tridium Niagara 4 JACE-8000 controllers. The contractor shall develop the system to accomplish the following as part of this project.
- E. The Niagara Compatibility Statement (NICS) for all Niagara Software shall allow open access and be set as follows: Accept Station In = \*; Accept Station Out = \*; Accept Tool In = \*; Accept Tool Out = \*. In any case, the District shall maintain the right to direct Tridium to modify any software license, regardless of supplier, as desired by the District.
- F. The JACEs shall provide fully distributed control independent of the operational status of the OWSs and Niagara 4 Supervisor Server. All necessary calculations required to achieve supervisory control shall be executed within the NC independent of any other device. All control strategies performed by the JACE's shall be both operator definable and modifiable through the Operator Interfaces.
- G. The total device count allowed on each Niagara JACE 8000 series network controller is as follows:
  - 1. Niagara N4 8005 Level Device: Do Not Use
  - 2. Niagara N4 8010 Level Device: 8 Devices
  - 3. Niagara N4 8025 Level Device: 20 Devices
  - 4. Niagara N4 8100 Level Device: 62 Devices
  - 5. Niagara N4 8200 Level Device: 62 Devices
- H. In addition to BACnet BTL listed controllers, all integrated controllers and equipment shall count as devices towards the capacity limits above. These include devices such as smart meters, communicating HVAC devices, and other integrated equipment.
- I. The JACE shall utilize I/O Expansion Modules (IO-16, IO-34, IO-16-485) for direct control of equipment.
- J. JACEs shall utilize the Niagara 4 Framework for discovery, installation, setup, configuration and commissioning of user defined BACnet and non-BACnet devices.
- K. JACEs shall perform overall system coordination, accept control programs, perform automated global HVAC functions, control peripheral devices and perform all necessary mathematical and logical functions.
- L. JACEs shall share information with the entire network of JACEs (FAC LAN) for full global control directly without requiring other JACEs, LAN devices, Local Supervisory LAN gateways, routers etc. to assist, perform, or act as an intermediate device for communicating.
- M. The JACE controller shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.
- N. Event Alarm Notification and Actions
  - 1. The JACE controller shall provide alarm recognition, storage, routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
  - 2. The JACE controller shall route any alarm condition to any defined user location whether connected to a local, remote or wide-area network.
  - 3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
    - a. To alarm
    - b. Return to normal

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- c. To fault
  4. Provide for the creation of a minimum of eight alarm classes for the purpose of routing types and or classes of alarms, i.e., security, HVAC, fire, etc.
  5. Provide routing of alarms by class, object, group, or node and time.
  6. Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
  7. Escalation of unacknowledged alarms to other recipients for up to three levels.
  8. Control equipment and network failures shall be treated as alarms and annunciated.
  9. Alarms shall be annunciated in any of the following manners as defined by the user:
    - a. Screen message text
    - b. Graphic with flashing alarm object(s).
    - c. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
      - d. Day of week
      - e. Time of day
      - f. Recipient
      - g. Mobile devices using SMS.
      - h. Printed message, routed directly to a dedicated alarm printer.
  10. The following shall be recorded by the NC for each alarm (at a minimum).
    - a. Time and date
    - b. Location (building, floor, zone, office number, etc.)
    - c. Equipment (air handler #, VAV #, etc.)
    - d. Acknowledge time, date, and user who issued acknowledgement
    - e. Number of occurrences since last acknowledgement
    - f. User defined notation
  11. Alarm actions may be initiated by user defined programmable objects created for that purpose.
  12. Required alarms shall be generated within the network controller. Alarms may be based on information from various sources, including information from ASCs, Control Units, AACs, and other integrated devices and systems. Information will be processed in the network controller, and alarms generated accordingly.
  13. When required alarms are not available directly from the control devices, information obtained from the devices can be tested against alarm thresholds and set-points within the network controller, and alarms generated accordingly.
  14. Alarm points created in the network controllers shall have set-points which are adjustable from appropriate browser based workstations by users with sufficient password levels.
  15. Users with sufficient password levels shall be authorized to acknowledge alarms, enter notes, etc., individually from the browser based operator workstations.
  16. Alarms generated by the JACE controllers shall be presented to appropriate workstations in a manner consistent with the presentation of other alarms.
    - a. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
    - b. A log of all alarms shall be maintained by the JACE controller and a server (if configured in the system) and shall be available for review by the user.
    - c. Provide a "query" feature to allow review of specific alarms by user defined parameters.
    - d. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
    - e. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.
- O. Data Collection and Storage:
1. The JACE controller shall collect data for any property of any object and store this data for future use.

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2. The data collection shall be performed by log objects, resident in the JACE controller that shall have, at a minimum, the following configurable properties:
3. Designating the log as interval or deviation.
4. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
5. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
6. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
7. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
8. All log data shall be stored in a relational database in the network controller and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.
9. All log data, when accessed from a server, shall be manipulated using standard SQL statements.
10. All log data shall be available to the user in the following data formats:
  - a. HTML
  - b. XML
  - c. Plain text
  - d. Comma or tab separated values
11. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.
12. The JACE controller shall archive its log data either locally (to itself), or remotely to a server or other network controller on the network. Configure the following archiving properties, at a minimum:
13. Archive each JACE to the Niagara 4 server daily at a specified time of day. Stagger JACE archive times to reduce network traffic.
14. Provide ability to clear logs once archived

P. Audit Log

1. Provide and maintain an Audit Log that tracks all activities performed on the network controller. Archive log based on time or when the log has reached its user-defined buffer size. Archive locally and to the Niagara 4 server. For each log entry, provide the following data:
  - a. Time and date
  - b. User ID
  - c. Change or activity (change set point, add or delete objects, commands, etc.)
  - d. Database Backup and Storage
2. The network controller shall automatically back up its database. The database shall be backed up based on a user-defined time interval. Request the District time interval at the beginning of the project.
3. Copies of the current database and, at the most recently saved database shall be stored in the network controller. The age of the most recently saved database is dependent on the user-defined database save interval.
4. The JACE controller's database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.
5. Provisioning - Automatic downloading of software updates, backups to the entire system database etc. based on user defined parameters.

Q. Network History Policies

1. JACE network controllers shall be configured to store trend data for the previous 48 hours before overriding. Trend data for the previous 24 hours shall be exported to the Niagara 4 server daily for archival. History exports from each JACE shall be

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staggered in 10 minute intervals to reduce network traffic.

- R. JACE Controller and Server Licensing Requirements
  - 1. All New and Existing JACE Controllers and Server equipment and software furnished by or integrated with this project shall be fully licensed to the Owner. The licensing rights shall include the rights for the Owner to authorize any Contractor of their choosing to perform work on the IAS system. The installing contractor shall hold no exclusive rights to the system as it pertains to software, hardware, system updates, system access, modifications, developed databases, etc.
  - 2. Provide the Owner all required user names and passwords for system access yielding full administration and configuration rights. These shall apply to work stations, servers, network controllers, configurable network electronics, controllers, system software / database and the like.
  - 3. The Contractor shall not limit in any fashion the ability for other contractors, vendors or operators the ability to manage, configure, or modify the parameters of each Network Controller, server or system software / database.
  - 4. The Contractor shall coordinate and hold no exclusive rights pertaining to inter-station links between Network Controllers.
  - 5. The owner shall have rights to update and modify site specific graphics, application programs and database files associated with the sequence of operation.
  - 6. The owner shall reserve the right and possess the ability to hire a contractor to service, maintain and modify the system. The ability to program, configure, and perform database modifications associated with of all the DDC controllers shall likewise be the property of the Owner. The Contractor shall hold no exclusive rights, or access levels to the system. Third party Contractors shall have full rights and access to the system at any point for system expansion or existing system modifications. All configurations shall be performed via Niagara 4 Supervisor®.
  - 7. Upon substantial completion the Contractor shall deliver as part of the O&M manuals to the owner electronic copies containing the current databases, Systems Usernames, Passwords and Access Levels for the following components:
    - a. JACE Controllers
    - b. DDC Controllers

## 2.4 JACE REMOTE/EXPANSION I/O

- A. JACEs shall provide the ability to directly control equipment through remote or expansion I/O modules.
- B. Remote I/O modules shall provide 8 universal inputs, 4 relay outputs and 4 analog outputs (T-IO-16-485)
- C. Extend control up to 4000 feet from the NC
- D. Power: 12-15 Vdc
- E. UL 916, CE listed, RoHS compliant
- F. Industry standard RS-485 multi-drop communication bus
- G. Up to 16 J-T-IO-16-485 devices can be connected to a single JACE providing a total of 256 I/O points
- H. 16 max per JACE-6E or JACE-7 series controller
- I. Environment

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1. Operating temperature range: 0°C to 50°C (32°F to 122°F)
  2. Storage Temperature range: 0°C to 60°C (32°F to 158°F)
  3. Relative humidity range: 5% to 95%, non-condensing
- J. Universal Inputs shall be:
1. Type III 10K ohm Thermistors
  2. Resistance 0-100 K ohms
  3. 0-10 Vdc
  4. 0-20 mA with the use of a 499 ohm resistor
- K. Relay Outputs shall be:
1. Form A contacts, 24 Vac @ 0.5 Amp
- L. Analog Outputs shall be:
1. 0-10 Vdc
- M. Expansion I/O modules shall provide 8 universal inputs, 4 analog outputs and 4 digital outputs (IO-16) or 16 universal inputs, 8 analog outputs and 10 digital outputs (IO-34).
- N. Environment
1. Operating temperature range: 0°C to 50°C (32°F to 122°F)
  2. Storage Temperature range: 0°C to 60°C (32°F to 158°F)
  3. Relative humidity range: 5% to 95%, non-condensing
- O. Power: 24 Vac/dc
- P. Universal Inputs shall be:
1. Type III 10K ohm Thermistors
  2. Resistance 0-100 K ohms
  3. 0-10 Vdc
  4. 0-20 mA with the use of a 499 ohm resistor
- Q. Binary Inputs minimum dwell time > 500 ms (Pulse counter range 20 Hz, 50% duty cycle)
- R. Analog Outputs shall be:
1. 0-10 Vdc each
  2. AO can supply at least 4mA over the entire 0-10 Vdc range
- S. Digital Outputs shall be:
1. Capable of switching loads up to .5A, 24 VAC
  2. Each output includes a MOV (metal oxide varistor) suppressor to support inductive type loads

## 2.5 BACNET IP ENABLED FIELD LEVEL CONTROLLER (B-BC)

- A. Acceptable Manufacturers- Subject to compliance with requirements, approved manufacturers are as follows:
1. The Distech Eclypse ECY line of BACnet IP controller series is listed as a sole source product in the District's design and construction standards. Alternate products will not be considered.
- B. The controller shall be BTL certified as a BACnet Building Controller (B-BC), supporting all associated BACnet Interoperability Building Blocks (BIBB's).
- C. BACnet/IP enabled controllers shall be provided for Unit Ventilators, Fan Coils, Heat Pumps,

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Variable Air Volume (VAV) Terminals and other applications as shown on the drawings.

- D. The controller shall be 32 bit microprocessor-based operating at a minimum of 600 MHz.
- E. They shall be multi-tasking, real-time digital control processor based supporting a fixed I/O point count.
- F. Performance
  - 1. Each controller shall have a 32-bit microprocessor and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135 and the BACnet Device Profile supported.
- G. All controllers shall be able to communicate peer-to-peer without the need for a separate network manager.
  - 1. Any controller on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.
- H. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
  - 1. Shall be fully programmable and the programming software shall have a library of pre-built, tested, and user re-definable control sequences for a wide range of typical HVAC applications.
  - 2. All control sequences programmed into the controller shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Controllers shall be fully programmable.
- I. BACnet Controllers shall communicate via a BACnet/IP connection at a baud rate of not less than 100 Mbps.
- J. BACnet field level controllers shall have a communications port for connecting a matching room temperature and/or humidity sensor and does not utilize any of the I/O points of the Controller.
- K. The Contractor supplying the BACnet Controllers shall provide documentation for each device, with the following information at a minimum:
  - 1. BACnet Device; MAC address, name, type and instance number.
  - 2. BACnet Objects; name, type and instance number
- L. It is the responsibility of the Contractor to ensure that the proper BACnet objects are provided in each BACnet controller, as required by the drawings and specifications.
- M. Each controller shall have minimum of 512MB memory, with a minimum of 4 GB non-volatile flash, to support its own operating system and databases, including: .
  - 1. Control processes
  - 2. Maintenance support applications
  - 3. Custom processes
  - 4. Energy management applications
  - 5. Alarm management applications
  - 6. Historical/trend data for points specified
  - 7. Embedded Web Server for local hosting of graphics.
- N. Power Requirements.
  - 1. 24 VAC with local transformer power.



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- O. The controller will support the following communications protocols: .
  - 1. BACnet/IP.
    - c. Supporting IPv4 addressing.
    - d. DHCP support and Auto DNS.
    - e. 2 - RJ45 ports each capable of supporting 10/100 Base-T.
      - 1) Supporting controller daisy-chain topology on the wired IP network via integrated switch functionality.
      - 2) Integrated fail-safe should allow for communication when the controller is powered down.
- P. If the above functionality is not available then appropriate router(s) and switches must be supplied to provide the functionality.
- Q. The controllers shall be powered from a 24 VAC source and shall function normally under an operating range of 20 to 28 VAC ( $\pm 15\%$ ), allowing for power source fluctuations and voltage drops.
- R. The controllers shall also function normally under ambient conditions of 41 °F to 104 °F and 0% to 90% RH (non-condensing).
- S. Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.

## 2.6 ADVANCED APPLICATION CONTROLLER (AAC) AND BUILDING CONTROLLER (BC)

- A. A BACnet® based DDC Advanced Application Controller (AAC) or Building Controller (BC) shall be provided where required to perform the sequence of operation. The AAC or BC shall be fully configurable and programmable via the GUI web browser. The controller shall store all specific control sequences and program settings in non-volatile memory.
- B. All AAC and BC processors shall be operating at 5 MHz or higher with 8K of RAM and 64K of Flash memory with a minimum 10 year memory retention between program downloads.
- C. Each AAC and BC shall perform all intended control functions in a 'standalone' mode should the unit incur a loss of communications.
- D. The complete AAC or BC including accessory devices such as relays, transducers, power supplies, etc., shall be factory-mounted, wired and housed in a NEMA 1 enclosure or as required by the location and local code requirements.
- E. Each AAC or BC shall communicate using BACnet MS/TP serial communications. Integrated HVAC equipment may communicate over BACnet IP protocol if MS/TP is not available from the manufacturer.
- F. All AACs and BC's shall be provided as self sufficient units to maximize reliability and shall include internal 'soft' clock, operating systems, communication timing and interrupt controls, and shall be suitable for the specified applications.
- G. In the event of a power outage or controller reset, each AAC and BC shall enter a preprogrammed state on power re-application. Upon application of power to the AAC/BC, all control conditions will start from an 'off' / 'closed' position or the default state. This state will be maintained for an automatically adjusted amount of time. Once this time delay has passed, the AAC/BC control sequence shall resume according to current values
- H. Network and controller-to-controller communications must conform to BACnet® standards.



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- I. All AACs and BC's shall be provided with a communications port to allow connection of any industry standard laptop PC and custom configuration tools. Program access via this communications port allows direct field modification of the configuration parameters.
- J. Digital Inputs
  - 1. All digital inputs shall be over voltage protected.
  - 2. Digital Input types supported by the AAC:
  - 3. Normally open contacts (24V and 120V).
  - 4. Normally closed contacts (24V and 120V).
  - 5. Current/no current.
  - 6. Voltage/no voltage.
  - 7. Pulse/Totalizer contacts.
- K. Digital Outputs
  - 1. All digital outputs shall be 24 volt AC, current sinking, 0.5 amp opto-isolated triacs.
  - 2. Digital outputs shall be capable of handling maintained as well as pulsed outputs for momentary or magnetic latching circuits. It shall be possible to configure outputs for 3-mode control (fast-slow-off) and 2-mode control.
- L. Analog Inputs
  - 1. All analog inputs shall be over voltage protected.
  - 2. The analog to digital resolutions shall be a minimum of 10 bit.
  - 3. Analog inputs shall accept the following temperature types: 10K Ohm thermistor, 20K Ohm thermistor, or 1K Ohm RTD.
  - 4. Inputs shall be configurable to accept a wide range of inputs including: 4-20mA, 1-5Vdc, 2-10Vdc, etc.
- M. Analog Outputs
  - 1. The AAC or BC shall accommodate true analog outputs. Voltage (0-10V) and current (4-20 mA) outputs shall be accommodated.
  - 2. All analog outputs shall be proportional current or voltage type.
  - 3. The digital to analog resolution shall be a minimum of 10 bit.
  - 4. Outputs shall be configurable so that 0-100% output commands can represent any portion of the output voltage/current range.
  - 5. Outputs shall be reversible so that an increasing output command yields a decreasing electrical signal.
- N. In addition to local physical or internal I/O, each AAC and BC shall support distributed or 'bound' I/O. This bound I/O can be used to allow the AAC to provide I/O data to another controller on the network or to allow another controller to provide data to the controlling AAC/BC.
- O. The following general modes of control shall be incorporated into each AAC and BC. The sequence of operations shown in Section 230993 and/or 259000 and on the IAS Drawings indicate the final control sequence and shall define the various modes of operation:
  - 1. Occupied shall be a mode designed for normal occupied control of an area during regular business hours. This mode shall have unique heating and cooling setpoints associated with it.
  - 2. Unoccupied shall be a mode designed for after hours control of an area. This mode shall have unique heating and cooling setpoints associated with it.
  - 3. Override shall be a mode designed to invoke normal occupied control during after hours of an area. This mode shall use the occupied heating and cooling setpoints.
  - 4. Morning Warm-Up on units with a outdoor air economizer shall be a mode designed for the pre-heat/pre-cool time before normal occupancy occurs. This mode shall allow heating or cooling as required by the occupied setpoints but it will prevent outdoor air from entering the space. The outdoor air will move to its minimum position once the

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morning warm-up mode is over and the occupied mode is activated.

## 2.7 BACNET COMMUNICATING THERMOSTAT

- A. Manufacturer: Subject to compliance with requirements, installing company qualifications, and manufacturer's qualifications, provide products by the following. The manufacturer shall provide DDC control hardware and software with BACnet conformance approvals from the BACnet Test Laboratory.
  - 1. Communicating Thermostats:
    - a. Distech Allure Communicating Thermostat RT Series
    - b. Approved Equal
- B. General Requirements:
  - 1. The low-voltage unit thermostat shall be capable of single stage heating and cooling or multistage 2 heating / 2 cooling and shall be programmable. The thermostat shall be have BACnet MS\_TP communication capabilities.
  - 2. Thermostat shall communicate with up to 10 zigbee Pro wall or ceiling mounted occupancy sensors, and provide stand by mode setpoint incorporating multiple wireless sensors.
  - 3. Thermostat shall achieve accurate temperature control using a PI proportional-integral algorithm.
  - 4. Thermostat shall be capable of local or remote override during unoccupied mode. The thermostat shall resume occupied setpoints and will revert back to unoccupied setpoints after a certain amount of time (adjustable from 0 – 24hours in one hour increments).
  - 5. Thermostat shall have configurable temporary or permanent local override setpoints. When the "temporary setpoints" mode is enabled, once the temporary occupancy timer expires, the setpoints will revert back to their default values.
  - 6. Thermostat shall have an adjustable "Unoccupied timer" integrated to change the occupancy mode from "Occupied" to "Standby" if no motion is detected.
- C. BACnet Requirements
  - 1. Each terminal unit shall have a BACnet® based DDC Application Specific Controller (ASC) designed to provide the specified sequences. The controller shall be BTL certified, shall store all specific control sequences and program settings in non-volatile memory.
  - 2. All ASC processors shall be operating at 5 MHz or higher with 8K of RAM and 64K of Flash memory with minimum 10 year memory retention between program downloads.
  - 3. Each ASC shall perform all intended control functions in a 'standalone' mode should the unit incur a loss of communications.
  - 4. The complete ASC including accessory devices such as relays, transducers, power supplies, etc., shall be factory-mounted, wired and housed in a NEMA 1 enclosure or as required by the location and local code requirements.
  - 5. Each ASC shall communicate using BACnet MS/TP serial communications. Integrated HVAC equipment may communicate over BACnet IP protocol if MS/TP is not available from the manufacturer.
  - 6. All ASCs shall be provided as self-sufficient units to maximize reliability and shall include internal 'soft' clock, operating systems, communication timing and interrupt controls, and shall be suitable for the specified applications.
  - 7. In the event of a power outage or controller reset, each ASC shall enter a preprogrammed state on power re-application. Upon application of power to the ASC, all control conditions will start from an 'off' / 'closed' position or the default state. This state will be maintained for an automatically adjusted amount of time. Once this time delay has passed, the ASC control sequence shall resume according to current values.
  - 8. Network and controller-to-controller communications must conform to BACnet®

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standards.

9. The following general modes of control shall be incorporated into each ASC. The sequence of operations shown in Section 25 95 00 and on the IAS Drawings indicate the final control sequence and shall define the various modes of operation:
  - a. Occupied shall be a mode designed for normal occupied control of an area during regular business hours. This mode shall have unique heating and cooling setpoints associated with it.
  - b. Unoccupied shall be a mode designed for after hours control of an area. This mode shall have unique heating and cooling setpoints associated with it.
  - c. Override shall be a mode designed to invoke normal occupied control during after hours of an area. This mode shall use the occupied heating and cooling setpoints.
  - d. Standby shall be a mode designed for normal occupied times when the HVAC scheduling software indicates that a classroom or event space will not be in use. This mode shall have unique heating and cooling setpoints associated with it.

## 2.8 PORTABLE WORKSTATION

- A. Field Level Controllers requiring software for programming or commissioning which does not exist on the campus at the time of installation shall be provided a portable workstation including all necessary software for programming, commissioning, and troubleshooting device. The portable workstation shall be capable of accessing all device data and configuration files. The Portable workstation shall be labeled with the Controller manufacturer and all installed software's. The portable workstation hardware shall meet the following requirements:
  1. Commercial standard with supporting 32- or 64-bit hardware (as limited by the direct-digital control system software) and software enterprise server.
  2. Windows 10 Pro and Microsoft Office Suite
  3. Minimum 2.8 GHz processor,
  4. Minimum 500 GB 7200 rpm SATA hard drive with 16 MB cache
  5. Minimum 2GB DDR3 SDRAM (minimum 1333 Mhz) memory
  6. 512 MB video card
  7. Minimum 16 inch (diagonal) screen
  8. 10-100-1000 Base-TX Ethernet NIC with an RJ45 connector or a 100Base-FX Ethernet NIC with an SC/ST connector
  9. 56,600 bps modem
  10. ASCII RS-232 interface
  11. 16 speed high density DVD-RW+/- optical drive.

## 2.9 CONTROL PANELS

- A. Provide control panels with suitable brackets for wall mounting, unless noted otherwise, for each control system. Locate panel adjacent to systems served. Mount center of control panels 60 inches above finished floor or roof.
- B. Interior Panels: Fabricate panels of 16-gage furniture-grade steel, totally enclosed on four sides, with removable perforated backplane, removable hinged door and keyed lock, with manufacturer's standard shop-painted finish and color. Control Panel enclosures shall be NEMA 1 rated. Lock shall be keyed identical for all Digital control panels provided for this project.
- C. Exterior Panels: Provide 16-gage 304 or 316 stainless steel NEMA 4X enclosures. Panel shall have hinged door, keyed lock, and integral, thermostatically controlled heater. Provide hinged deadfront inside panel when flush-mounted control and/or indicating devices are included in panel. Fiberglass or aluminum, as applicable, to be used when gases that are being used in the panel area are corrosive to stainless steel.

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- D. Provide UL-listed cabinets for use with line voltage devices.
- E. Control panel shall be completely factory wired and piped, and all electrical connections made to a terminal block. All wiring from field devices must terminate on Terminal Blocks. Connections made in the panel shop will then interconnect from the Terminal Block to the Controllers.
- F. Provide a 6 inch x 6 inch minimum wireway (metal wiring/tubing) trough across the entire width of the panel mounted to the top of the panel with close nipples of sufficient size for additional 50 percent wiring and tubing capacity. Wireways shall not be less than 24 inches in length. Control panel wiring shall be installed and distributed in the wireway to minimize routing of wiring and tubing within the control panel. Wireway construction to be the same as the associated control panel.
- G. Each control panel shall have a power transformer with integral disconnect switch and 120V Power outlet as defined on the IAS drawings.
- H. All Digital Control panel wire/tubing paths shall be housed in Panduit (open slot wiring duct with cover).
- I. Each Control Panel shall have permanently affixed lamacoid label with the following information:
  - 1. Control Panel number (DCP-1, DCP-2, NCP-X etc.).
  - 2. Equipment served (Chiller 1, AHU-1, etc.).
  - 3. Circuit Breaker number feeding panel.
  - 4. All gauges and control components shall be identified by means of nameplates.
  - 5. Complete wiring and tubing termination drawings shall be mounted in, each panel in a frame with lexan cover of sufficient size to be easily readable.
  - 6. Sheet metals screws shall not penetrate the cabinet walls, door, or back.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Owner.
- B. Beginning of installation means installer accepts existing conditions.
- C. Communications wiring is indicated on the contract documents. Examine the site and identify any potential problems or conflicts. Submit recommended modifications and omissions to the Owner's representative.

### **3.2 INSTALLATION**

- A. Installation shall meet or exceed all applicable Federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations.
- C. Mount control panels adjacent to associated equipment on vibration-free walls or free-standing angle iron supports. One cabinet may accommodate more than one system in same equipment room.

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- D. After completion of installation, test and adjust control equipment. Submit data showing setpoints and final adjustments of controls to the District.
- E. Mount all I/O and ancillary devices per manufacturer's installation instructions and in the locations shown on the drawings.

### **3.3 SYSTEM ACCESS**

- A. Provide an Ethernet connection and a 5 port hub at each panel housing a JACE Controller or controllers. The user shall be able to access each controller on the system using this connection via the Control System Server database for graphics, schedules, programming, controller configuration etc.

### **3.4 HARDWARE APPLICATION REQUIREMENTS**

- A. Standalone Capability:
  - 1. Each Controller shall be capable of performing the required sequence of operation for the associated equipment.
  - 2. All physical point data and calculated values required to accomplish the sequence of operation shall originate within the associated Controller with only the exceptions enumerated below. Listed below are functional point data and calculated values that shall be allowed to be obtained from or stored by other Controllers via the FAC LAN.
  - 3. Where associated control functions involve functions from different categories identified below, the requirements for the most restrictive category shall be met.
  - 4. Application Category 0 (Distributed Monitoring):
  - 5. Applications in this category include the following:
  - 6. Monitoring of variables that are not used in a control loop, sequence logic, or safety.
  - 7. Points on JACEs, AACs, and ASCs may be used in these applications as well as IASs and/or general-purpose I/O modules.
  - 8. Where these points are trended, Contractor shall verify and document that the network bandwidth is acceptable for such trends and is still capable of acceptable and timely control function.
- B. Standalone Capability:
  - 1. Provide capability to execute control functions for the application for a given setpoint or mode, which shall generally be occupied mode control.
  - 2. In the event of a loss of communications with any other controller, or any fault in any system hardware that interrupts the acquisition of any values, the controller shall use the last value obtained before the fault occurred.

**END OF SECTION 25 14 00**

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**SECTION 25 15 00**  
**IAS SOFTWARE AND PROGRAMMING TOOLS**

**PART 1 GENERAL**

**1.1 RELATED SPECIFICATIONS:**

- A. Section 250600 - Network Scheduling Software for HVAC
- B. Section 250800 – Fault Detection and Diagnostics Software for HVAC
- C. Section 250900 – Chiller Plant Optimization Software
- D. Section 250000 – Integrated Automation Systems (IAS) For HVAC
- E. Section 251400 – IAS Network Controllers for HVAC
- F. Guideline A - IAS Graphics Requirements
- G. Guideline B - IAS Point Naming and Tagging Convention

**1.2 SUMMARY**

- A. This section describes the features and requirements of the hardware and software necessary to manage the Integrated Automation System (IAS) Control Networks. Section Includes:
  - 1. Network Management
  - 2. Graphical User Interface
  - 3. System Software
  - 4. Application Programming Description
  - 5. Application Control Logic
  - 6. Application Builder
  - 7. Energy Management Applications
  - 8. Graphical User Interface Software
  - 9. User Management
  - 10. Point Structuring
  - 11. Trending
  - 12. Alarm Reporting
  - 13. Dynamic Color Graphics
- B. Fully configure systems and furnish and install all software, programming and dynamic color graphics for a complete and fully functioning system as specified.
- C. Provide network management of all IAS control devices.
- D. Provide custom set-up and development of the software to provide the functional and performance requirements specified. Develop system graphics for all specified mechanical and electrical systems, using animated objects to display all system variables and process valves. Design package shall include sample screen shot captures or the Graphics Requirements Exhibit to define the presentation, operation and navigation to be provided within the GUI.
- E. Provide supervisory control strategies for mechanical and electrical systems to permit the global sequence of operations specified herein.

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- F. Network Operating Software requirements as outlined in Section 25 00 00 (IAS) Integrated Automation System.
- G. Full RAS and WAN support.
- H. Provide System Diagnostics to proactively maintain continuous operation of all IAS network devices.
- I. Refer to Section 25 00 00 – Integrated Automation System (IAS) General for general requirements as well as requirements for interface with Owner's WAN.

### 1.3 SUBMITTALS

- A. General: Submit under provisions of Division 01. In addition, an electronic version of the completed materials shall be provided on electronic media. Data can be in native file format or scanned where necessary. Provide a complete and comprehensive submittal package. Partial submittals shall not be accepted. Upon completion submit all compliance data and project record documents.
- B. Preconstruction Submittals.
  - 1. IAS Graphics Submittal: A copy of each of the graphics developed for the Graphic User Interface including a flowchart (site map) indicating how the graphics are to be linked to one another for system navigation. The graphics are intended to be 80% - 90% complete at this stage with the only remaining changes to be based on review comments from the A/E design team and/or Owner.
  - 2. The graphics submittal is due within 90 days of the award of contract.
  - 3. Include a minimum of 120 additional hours and four Owner meetings to revise graphics based on Owner and design team comments.
  - 4. Detailed point list. Include all hardwired points, integrated points, virtual points, and alarms. Indicate read/write capability of all points. Indicate proposed trending periods and frequencies for all points. Use the following ASHRAE Guideline 13 recommended format:

POINT NAME	HARDWARE POINTS				SOFTWARE POINTS			TREND FREQUENCY (MIN)	SHOW ON GRAPHIC (Y/N)	COMMENTS
	AI	AO	DI	DO	AV	DV	SCHED			

- 5. Point Summary Report: Provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID, object ID (object type, instance number). See Section 25 15 00 and the Graphics Requirements Guideline for additional requirements.
- C. Construction Submittals
  - 1. Provide the results of BACnet Protocol Analyzer testing for each BACnet MSTP subnetwork added or modified as part of the project. Run the protocol analyzer software for a minimum 24 hour period and submit the results. Data included shall include data traffic, average measured bandwidth usage, and a summary of discovered BACnet devices.
  - 2. Seventy-Two (72) Hour Trend Data: Upon completion of testing provide a seventy-two (72) hour data indicating complete operation of the IAS System. The Trend Data shall be in the form of color Trend Graphs and associated data in Microsoft Excel format. Provide Trend Data graphs for each piece of HVAC equipment or plant to demonstrate compliance with the project sequence of operation. Provide setpoint trends along with measured value trends to compare setpoint to performance. Submit



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specified list of points and graphic format of trending for approval prior to commencement of 72-hour trending.

3. Alarm Reports: Provide a list of all alarms, alarm limits, delays, priorities, and programmed actions associated with alarms.

D. Closeout Submittals

1. Provide the End User License Agreement (EULA) associated with all MiraCosta software as part of the MiraCosta product submittal package.
2. Control Logic Documentation: Submit control logic program listings (for graphical programming) and logic flow charts illustrating (for line type programs) to document the control software of all control units. Submit functional temperature control diagrams for each mechanical system served by the IAS. Indicate and tag each input/output served by each ASC or AAC and show locations and functions of ISA's

#### 1.4 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. Refer to Guideline A - IAS Graphics Requirements for additional requirements regarding the District's licensed graphic theme and toolset for IAS systems.
- C. All referenced amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- D. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within all references.

#### 1.5 LICENSING

- A. Provide or upgrade all licensing for all software packages at all required Niagara 4 JACE Network Controllers and Supervisors. IAS licensing shall allow unlimited simultaneous users for access to all aspects of the system including system access, workstations, points, programming, database management, network management, graphics etc. All operator interfaces, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the Owner. All Niagara 4 Supervisors shall have NICs set for open communication by all vendors as defined in section 25 00 00.
- B. At least two (2) sets of electronic storage media shall be provided with backup software for all software provided, so that the Owner may reinstall any software as necessary. Include all licensing for workstation operating systems, and all required third-party software licenses.
- C. In the last month of the Warranty Period, upgrade all software and firmware packages to the latest release (version) in effect at the end of the Warranty Period.
- D. Refer to Section 25 00 00 - Integrated Automation System (IAS) General for further requirements.

#### 1.6 NETWORK MANAGEMENT

- A. The Contractor shall furnish network management hardware and software to logically manage, configure and program the IAS Control Devices locally. The Contractor shall provide network management of the IAS Control Devices. Network management shall include the following services: Device installation, device configuration, device diagnostics,



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programming, device maintenance, network variable binding, channel traffic analysis, message priority levels, alarm message routing and repeating and protocol conversion.

- B. Network Management Software shall be an intuitive interface for network design and installation and act as a bridge to integrate BACnet and Siemens P1/P2 devices. The Network Management tool shall include all software modules necessary to provide complete network management, configuration, programming and maintenance locally and via the GUI web browser.

## 1.7 GRAPHICAL USER INTERFACE

- A. Acceptable Manufacturers - Subject to compliance with requirements, approved manufacturers are as follows:
  - 1. Acuity Brands DGLux5 graphical user interface software is listed as a sole source product in the District's design and construction standards. Alternate products will not be considered.
- B. The Graphical User Interface on the MiraCosta network shall be provided in whole through DGLogik's DGLux 5 visualization software (aka Atrius IoT Solutions 1 aka Envysion). All MiraCosta Command and Control and functionality shall be provided within the DGLux environment. DGLux is listed a sole-source product in the District's design and construction standards. Alternate products will not be considered acceptable. Embedded screen interfaces from other thin client applications are not acceptable. Provide the following functionality:
  - 1. The User Interface software shall include support for building automation supervisory control, data acquisition, alarming, historical data collection and trending, and management report generation. The software shall be developed using a Windows based, 32 bit or 64 bit, object oriented programming language. The User Interface software shall have an open architecture design that allows the system to run in a multi-tasking, multi-user environment with support for on-line, dynamic data exchange and the latest version of ODBC with other applications such as spreadsheets, and database programs. The system shall have the built-in flexibility to permit easy configuration of the system in accordance with the specific objectives of the end user, as well as quick and easy modification of the end application by the user in the field.
  - 2. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. Refer to Guideline A. In addition, menu pull-downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.
  - 3. Real-Time Graphic Displays. The GUI shall, at a minimum, support the following graphical features and functions:
    - a. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, PDF, or JPG file format. Use of proprietary graphic file formats shall not be acceptable.
    - b. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
    - c. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

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- d. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
- e. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and entering the desired value.
- 4. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:
  - f. Create, delete or modify control strategies while the Network Controller is online.
  - g. Add/delete objects and network variables to the system.
  - h. Tune control loops through the adjustment of control loop parameters.
  - i. Enable, disable or create control strategies; configure and program controllers.
  - j. Generate hard copy records or control strategies on a printer.
  - k. Select points to be alarmable and define the alarm state.
  - l. Select points to be trended over a period of time and initiate the recording of values automatically.
- C. Web Browser Interface Description:
  - 1. The system shall be capable of supporting an unlimited number of clients using a standard Web browser (e.g. Chrome™, Internet Explorer™, FireFox™). Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
  - 2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the IAS, shall not be acceptable.
  - 3. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
  - 4. The Web browser client shall support at a minimum, the following functions:
    - a. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
    - b. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
    - c. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
    - d. Storage of the graphical screens shall be in the network web server, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
    - e. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
    - f. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
      - 1) Modify common application objects, such as schedules, calendars, and set-points in a graphical manner. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
      - 2) Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.

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- 3) View logs and charts.
  - 4) View and acknowledge alarms.
  - 5) Set up and execute SQL queries on log and archive information.
  - g. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
  - h. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.
- D. Alarm console
- 1. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
  - 2. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop. This window will notify the operator of new alarms and un-acknowledged alarms.

## **PART 2 PRODUCTS**

### **2.1 GENERAL**

- A. All materials shall meet or exceed all applicable referenced standards, Federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

### **2.2 SYSTEM SOFTWARE-GENERAL**

- A. Functionality and Completeness: Contractor shall furnish and install all software and programming necessary to provide a complete and functioning system as specified. Contractor shall include all software and programming not specifically itemized in these Specifications, which is necessary to implement, maintain, operate, and diagnose the system in compliance with these Specifications.
- B. Configuration: The software shall support the system as a distributed processing network configuration and shall utilize Niagara 4 Supervisor for engineering, installation and commissioning.
- C. Database: The Niagara Supervisor server software shall be purchased with an SQL license and configured to automatically push all historian trend data to the District's Microsoft SQL Server database.

### **2.3 NETWORK MANAGEMENT SOFTWARE**

- A. General: Utilize Niagara 4 Supervisor
- B. Network Management clients shall be capable of performing the following network services by accessing the appropriate network node databases from the Network Services Server:
  - 1. Device / node installation
  - 2. Device / node configuration
  - 3. Device / node diagnostics
  - 4. Device / node maintenance
  - 5. Programming
  - 6. Network variable binding

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7. A network variable browser
  8. A graphical user interface
  9. System diagnostics
- C. The Network Management Server Application shall reside on the IAS Local Area Network server. This application shall support multiple thin clients on the Local Area Network via the GUI web browser.
- D. Direct Ethernet based driver support for BACnet I/P, OPC (Client), Modbus TCP, LON IP and SNMP.

## 2.4 CONTROLLER SOFTWARE

- A. JAVA APPLICATION CONTROL ENGINE (JACE) CONTROLLER Software Residency: Each JACE as defined below shall be capable of control and monitoring of all points physically connected to it. All software including the following shall reside and execute at the JACE controller:
1. Real-Time Operating System software
  2. Real-Time Clock/Calendar and network time synchronization
  3. JACE diagnostic software including resource management, memory utilization, scan times, device counts and device status and logging of internal operations
  4. Direct Digital Control software including a library of control objects to perform standard BMS functions as specified in the sequence of operation.
  5. Energy Management software including a library of objects to perform energy management functions as specified in the sequence of operations.
  6. I/O (physical and virtual) database- supporting up to 32 field I/O modules as required for the sequence of operation.
- B. Alarm services software to provide:
1. On call notification services and reporting
  2. Programmable Floating alarm limits
  3. Emailing of alarms including alarm escalation
  4. SMS, line printer, station recipient
  5. Alarm acknowledgement via email, SMS and remote alarm portal
  6. Alarm history acknowledgement with history and user notations.
  7. A minimum of 100 alarm classes
- C. Audit History shall store changes made to objects including time stamp, object name, old value, new value and user identification of the user making the modifications.
- D. Backup service shall be automatically provided to include the entire JACE controller. The backup service shall have the ability to exclude specific files in the backed up database.
- E. Email Service shall create individual incoming and outgoing email accounts, an email alarm acknowledger, and shall specify email recipients as requested by the District during the project configuration.
- F. History Service shall provide access to histories of all activity in the JACE. The service shall allow the operator to enable/disable all history collection with a single operation. Tagging of the history files shall allow the user to group and combine histories into a single file.
- G. User and Category Service shall support RSA secureID or LDAP or active directory integrations. The user service shall provide for the capability to create unique users with defined expiration intervals, warning periods and password history length. This service shall provide the ability to define object access, navigation to specific objects or graphics, define

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the user profile. User access shall be capable of being disabled based on time of day.

- H. Weather Service shall provide current weather as well as forecast weather conditions by receiving the current and forecasted weather from any NOAA (National Oceanic and Atmospheric Administration) weather servers. Data obtained from this service may be used for optimization routines as required in the JACE.
- I. Web Service shall provide unlimited web access service to the JACE. No user seats or licenses shall be required. It shall support HPPT, HTTPs (SSL and/or TLS) Encryption certificates. The service shall allow the user to specify ports other than the default HTTP/HTTPS ports.
- J. Platform Services shall provide the ability to perform:
  - 1. TCP/IP network management
  - 2. License management
  - 3. Serial port configuration and management
  - 4. Certificate management for SSL/ TLS certificates and shall include key store, trust store and lowered ost management. The tool shall provide the ability to create certificates and manage certificates from third parties.
- K. Field device Network management – all communication drivers (BACnet, Modbus etc) shall utilize a single field device network manager tool that provides a common look and feel without regard to protocol.
- L. Operating System: Controllers shall include a real-time operating system resident in ROM. This software shall execute independently from any other devices in the system. It shall support all specified functions. It shall provide a command prioritization scheme to allow functional override of control functions.
- M. Network Communications: Each controller shall include software/firmware that supports the networking of controllers on a common communications trunk. Network support shall include the following:
- N. Controller communication software shall include error detection, correction, and re-transmission to ensure data integrity.
- O. Operator/System communication software shall facilitate communications between other JACEs, all subordinate AACs/ASCs, Gateways and LAN Interface Devices or Operator Workstations. Software shall allow point interrogation, adjustment, addition/deletion, and programming while the controller is on line and functioning without disruption to unaffected points. The software architecture shall allow networked controllers to share selected physical and virtual point information throughout the entire system.
- P. Network Management: Point/system database creation and modification shall be via a user-friendly, menu-driven program. Network Management software shall support virtual or logic point (points not representing a physical I/O) creation.
- Q. Diagnostic Software: Controller software shall include diagnostic software that checks memory and communications and reports any malfunctions.
- R. Alarm/Messaging Software: Controller software shall support alarm/message processing and buffering software as more fully specified below.
- S. Application Programs: Controllers shall support and execute application programs as more fully specified below:

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- T. All Direct Digital Control software, Energy Management Control software, and functional block application programming software templates shall be provided in a 'ready-to-use' state, and shall not require (but shall allow) Owner programming.
- U. Line programs shall supply preprogrammed functions to support energy management and functional block application algorithms. All functions shall be provided with printed narratives and/or flow diagrams to document algorithms and how to modify and use them.
- V. Security: Controller software shall support multiple level password access restriction.
- W. Direct Digital Control: Controller shall support application of Direct Digital Control Logic. All logic modules shall be provided pre-programmed with written documentation to support their application. Provide the following logic modules as a minimum:
  - 1. Proportional-Integral-Derivative (PID) control with analog, PWM and floating output.
  - 2. Two Position control (Hi or Low crossing with deadband).
  - 3. Single-Pole Double-Throw relay.
  - 4. Delay Timer (delay-on-make, delay-on-break, and interval).
  - 5. Hi/Low Selection.
  - 6. Reset or Scaling Module.
  - 7. Logical Operators (And, Or, Not, Xor).
- X. Psychometric Parameters: Controller software shall provide preprogrammed functions to calculate and present psychometric parameters (given temperature and relative humidity) including the following as a minimum: Enthalpy, Wet Bulb Temperature.
- Y. Updating/Storing Application Data: Site-specific programming residing in volatile memory shall be uploadable/downloadable from an OWS or CSS connected locally, to the FAC LAN, to the device level network and remotely via the Internet as applicable, but all must be available.
- Z. Restart: System software shall provide for orderly shutdown upon loss of power and automatic restart upon power restoration. Volatile memory shall be retained; outputs shall go to programmed fail (open, closed, or last) position. Equipment restart shall include a user definable time delay on each piece of equipment to stagger the restart. Loss of power shall be alarmed at operator interface indicating date and time.
- AA. Time Synchronization: Operators shall be able to set the time and date in any device on the network that supports time-of-day functionality. The operator shall be able to select to set the time and date for an individual device, devices on a single network, or all devices simultaneously. Automatic time synchronization shall be provided.
- BB. Miscellaneous Calculations: System software shall automate calculation of psychometric functions, calendar functions, kWh/kW, and flow determination and totalization from pulsed or analog inputs, curve-fitting, look-up table, input/output scaling, time averaging of inputs and A/D conversion coefficients.

## 2.5 FIELD LEVEL CONTROLLER SOFTWARE

- A. Provide field controllers software for programming, commissioning, or other configuration, furnished on a portable laptop workstation. The BAS Contractor shall furnish the Owner with a portable laptop workstation preloaded with all software needed to connect to, communicate with, command, program, and commission field panels and controllers at no additional charge to the Owner.
- B. Hardware and software covered under this requirement includes, but is not limited to:



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1. All software tools, configuration tools, management tools, and utilities used during system commissioning and installation.
2. Communication modules, software keys, and similar hardware needed for communication from a laptop computer or PDA to field panels or controllers
3. Proprietary cables required for communication between laptop computers or PDAs to field panels or controllers
4. Proprietary software needed to communicate to field panels or controllers such as HVAC Pro, Metasys, Commissioning Tool, etc.
5. Passwords, access levels and similar software permissions necessary for execution of the Cx Process.
6. Software and hardware manuals for all control system hardware and software provided to the Owner

## 2.6 APPLICATION PROGRAMMING DESCRIPTION

- A. The application software shall be user programmable.
- B. This Specification generally requires a programming convention that is logical, easy to learn, use, and diagnose. General approaches to application programming shall be provided by one, or a combination, of the following conventions:
- C. Point Definition: Utilize Niagara 4 Supervisor to support input of individual point information.
- D. Graphical Block Programming: Manipulation of graphic icon 'blocks', each of which represents a subroutine, in a functional/logical manner forming a control logic diagram. Blocks shall allow entry of adjustable settings and parameters via pop-up windows. Provide a utility that shall allow the graphic logic diagrams to be directly compiled into application programs. Logic diagrams shall be viewable either off-line, or on-line with real-time block output values.
- E. Functional Application Programming: Pre-programmed application specific programs that allow/require limited customization via 'fill-in-the-blanks' edit fields. Typical values would be setpoints gains, associated point names, alarm limits, etc.
- F. Line Programming: Textual syntax-based programming in a language similar to BASIC designed specifically for HVAC control. Subroutines or functions for energy management applications, setpoints, and adjustable parameters shall be customizable, but shall be provided preprogrammed and documented.
- G. Provide a means for testing and/or debugging the control programs both off-line and on-line.

## 2.7 APPLICATION CONTROL LOGIC

- A. The following type of process variable types shall be supported:
  1. Discrete: On/Off or 0/1
  2. Integer: 32 bit signed integer value between -2,147,483,648 and +2,147,483,647
  3. Real: +/- 3.4 E38
  4. String: Text string up to 131 characters long
- B. System shall have the ability to execute user defined logic scripts. Logic scripts shall be created in an object or statement based programming environment. No compilers or linkers shall be required.
- C. System logic shall be able to automatically perform functions such as increase set-points, perform totalization, and check the status of process set-points to take action.

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- D. System logic shall be able to control and start other application programs running in the multi-tasking environment.
- E. System logic shall be able to monitor the status of each process variable in the system, and perform specific functions based on the following parameters:
 

Normal Status	Alarm Status
LoLo Alarm Status	Lo Alarm Status
Hi Alarm Status	HiHi Alarm Status
Logical Result of Boolean Expression	Individual Bit in Word Status (0-31)
Acknowledged Alarm Status	Unacknowledged Alarm Status
- F. System shall have the capability to perform application control to turn on/off discrete points, show windows, download recipes, etc. This application logic shall also start and stop other application programs in the multitasking environment, including spreadsheet programs, database programs, and recipe storage programs. Condition Logic shall be able to support up to 32,767 bytes of memory and shall support the following command functions:
  - 1. String Functions
  - 2. Math Functions
  - 3. System Functions
  - 4. Add-On Functions
  - 5. Miscellaneous Functions
- G. System shall have the capability to perform application control based upon a user definable state of a process variable or the result of an expression involving multiple process variables. This includes discrete variable on or off state, alarm states such as HIHI or LOLO, or equivalence to a specific value.
- H. System shall have the ability to execute System Logic when the value of a Process Variable changes.

## 2.8 APPLICATION BUILDER CAPABILITIES

- A. Graphics development tools shall allow the creation of filled rectangles, circles/ellipses, polygons, and arcs. All display elements such as real time and historical trends, alarm summary displays, bitmap images, and charts shall be configurable objects with the capability to be placed in any window in any configuration.
- B. The graphic drawing system shall be object-oriented.
- C. The system shall support the import of .DXF files with the drawing elements imported as native objects. It shall be possible to animate these objects using the full set of object animation properties.
- D. Graphics editor shall also allow the user to import drawings and images in .BMP file format.
- E. In order to ensure the most productive graphics development environment, animated graphic objects or symbols shall be copyable in just two keystrokes, and immediate substitution of a tag name for the duplicated object shall be possible without leaving the graphics editor.
- F. Animated graphic objects or process symbols shall be copyable from one window or display to another with all of their animation characteristics retained, thereby eliminating duplication of effort. In addition, it shall be possible to import windows from another application in this same fashion.
- G. User shall have the capability to add tag name dictionary items while building a display



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without exiting the graphics editor.

- H. User shall have the capability to search for process tag names while building a display and then get the exact detail of the item (alarm set-points, I/O address, and all other dictionary details) while building a display without exiting the graphics editor.
- I. User shall have online context sensitive help on the display build routines to be able to obtain immediate help should he or she have a question about the details of linking objects to the tag name database dictionary.
- J. The user shall be able to configure graphic screens while the system is monitoring the process.
- K. User shall have the capability to edit tag name items and add new tag names while the system is running the process.
- L. It shall be possible to export the entire database in .CSV format for import and subsequent editing to a spreadsheet such as Excel.
- M. It shall be possible to import the entire database from a .CSV file created with Excel.
- N. A built-in editor shall be provided for the development of logic scripts. The editor shall be a full-featured text editor with single keystroke entry of Tag names, logic constructs and script functions. When a script function is placed in the editing window any arguments necessary for the script function to operate shall be automatically pasted into the window.
- O. Online help shall be provided for all script functions.
- P. The user shall be able to configure and edit logic scripts while the system is monitoring the process.

## **2.9 REPORT WRITER**

- A. Report Printing Capability
- B. Printed reports shall contain process information including process data, status, accumulated variables, etc.
- C. Reports shall have the capability to include a snapshot of trends, histograms, and SPC charts on the printed report.
- D. Reports shall support use of graphic templates in a printed report.
- E. Report Scheduling
- F. Reports shall be able to be scheduled by time of day, day of week, hour of day, or at the end of a shift.
- G. Reports shall be able to be printed on demand by the operator.
- H. Reports shall be able to be printed based on any state change in the system.

## **2.10 ENERGY MANAGEMENT APPLICATIONS**

- A. System shall have the ability to perform all of the following energy management routines via

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preprogrammed function blocks or template programs. As a minimum provide the following whether or not required in the software:

1. Meets ANSI C12.20 Accuracy Standard
2. Time-of-Day Scheduling
3. Calendar-Based Scheduling
4. Holiday Scheduling
5. Temporary Schedule Overrides
6. Optimal Start/Optimal Stop-based on space temperature offset, outdoor air temperature, and building heating and cooling capacitance factors as a minimum
7. Night Setback and Morning Recovery Control, with ventilation only during occupancy
8. Economizer Control (enthalpy set-up for heating and cooling)
9. Peak Demand Limiting / Load Shedding
10. Dead Band Control

- B. The User Interface HVAC application package shall automatically perform predefined calculations based on operated input, real-time data and required constants. Calculations shall be defined for evaluation by both the User Interface and IAS LAN Clients. Calculations shall include, but not be limited to, the following
1. Enthalpy: Calculate total heat of air by sensing dry bulb and either relative humidity, wet bulb, or dew point
  2. Relative Humidity: Calculate RH from dry bulb temperature and either wet bulb or dew point. Acronym and type of sensor shall be operator input.
  3. Liquid Flow: Calculate flow rate from differential pressure across an orifice or venturi, or from an annubar sensor. Sensor acronym and type shall be operator input.
  4. Zone Heat Energy: Calculate total heat energy in a zone based on dry bulb and either wet bulb, relative humidity, or dew point, and the volume of the space. All parameters shall be operator input.
  5. Electrical Power: Calculate electrical power based on voltage and amperage, or on pulse meter input
  6. Fluid Btu Rate: Based on flow and differential temperature
  7. Addition/Subtraction/Multiplication/Division/ - Min/Max/Increment/ Decrement: Add, subtract, multiply, divide, selection of min or max for a number of real values and/or constants, and increase or decrease value by a fixed amount to obtain a virtual value.
  8. Steam Flow: Calculate steam flow from pressure and temperature values
  9. Steam Energy: Btu of steam flow
  10. General Degree Three Polynomial.
  11. Degree Days
- C. Calculated points for which all component data is available within the realm of a single Control Unit shall be downloaded to the Network Controller or IAS LAN Server for calculation. Changes of state shall be reported to the IAS LAN Server as described for analog points. The definition of such a point shall include the creation of a free form algorithm using a command language designed specifically for User Interface applications. In addition to the arithmetic operators listed above, the algorithm shall allow trigonometric, logarithmic, and exponential terms. The time increment of calculating such points shall be on a resolution of 10 seconds.
- D. Calculations requiring data from more than one controller shall be defined for evaluation by the User Interface Workstation. The operator shall choose the output units for the calculations from a list. The operator shall be able to determine the time increment for performing calculations on a resolution of 1 minute. Each calculated point shall be assigned a calculation priority which dictates the order in which the calculations are performed. Acronyms of sensed values shall be input by the operator. The operator shall input the value of required constants.
- E. Calculated points shall be defined through the operator's terminal in the same manner as

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sensed points with additional information requested as required. The calculated point shall appear to the operator as any real point (with a sensor) and the operator shall be able to use the acronym of the calculated point in the same manner as a real point.

- F. Run-time Totalizing: Provide the capability to totalize the number of hours that any binary point in the system is in the "on" condition. The point may be a motor, lights, unlocked doors, and so forth. Every binary point shall be able to be totalized on operator assignment.
1. The operator shall be able to set limits associated with run-time. Provide capability to have a limit with every binary point. Limits shall be set through the operator's keyboard. The system shall print an alarm on the event printer when the run-time of a point reaches the run-time limit. Run-time totals and limits shall be able to be reset from the operator's terminal on command.
  2. The operator shall be able to list a summary of run-time totals and each associated limit, if any. The summary shall be of all binary points or restricted to a particular location, system or point. The summary shall also be able to be restricted to those points that have reached the run-time limit.
- G. Analog Totalizing/Averaging: Any analog or calculated point in the system shall be able to be assigned to the totalized and/or averaging program. The points assigned shall be totalized for averaged as minimum of once a minute. The following totals and averages for each point assigned shall be kept in storage.
1. Last 12 Months, by Month
  2. Last 30 Days, by Day
  3. Last 24 Hours, by Hour
  4. Last Hour, by 5 Minute Increments
  5. Last 10 Minutes, by Minute
- H. Time Based Control
- I. Any commandable point in the system shall be able to be assigned a specific command by time of day and day(s) of week through the operator's terminal. The number of commands per point, per day, shall be limited only by the amount of memory available in the respective controller.
1. The following commands shall be available:
    - a. Start
    - b. Stop
    - c. Auto
    - d. Low
    - e. High
    - f. Change set-point
    - g. Change high limit
    - h. Change low limit
  2. Points shall be assigned time windows in which the assigned command is valid. Points shall be able to be assigned different time windows each day of the week plus a holiday schedule. Provide a means of deleting points from the time schedule by day(s) and time window.
  3. Provide a time delay between starts, within an individual controller, that shall be adjustable on a per point basis.
  4. Time schedules shall be downloaded to the respective controller for implementation. Loss of communication with the User Interface Workstation shall not affect the operation of downloaded time schedules. Any changes made by a time schedule shall be communicated to the User Interface Workstation and saved to the IAS LAN Server.
  5. The operator shall be able to list summaries of time schedules on the operator's terminal or data logger. The summary shall indicate the point and the various time windows assigned for that particular day. The summary shall be able to be restricted

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- to a particular location, system, system type, point type, or point as well as to those days of the week desired.
6. Provide a means of scheduling holidays one year in advance. The system shall recognize scheduled holidays and run the holiday schedule for that day or days. The holidays shall be defined through the User Interface Workstation.
  7. Provide a means to extend the time of equipment operation in a particular zone. The extended time shall be initiated from an operator's keyboard or for a binary input request from the one itself. The extension shall be for a user defined period (minutes, days) and the system shall automatically use the normal schedule the next day. The zone, equipment within the zone (motors, lights, and so forth), and the length of the time extension shall be defined through the User Interface Workstation. Provide a summary of zone parameters and a summary of zones currently operating under extended time.
- J. Time and Event Programs: Provide a method for automatically running programs based on occurrence of specified changes in the status of any binary, analog, or calculated point.
1. The following changes in status shall be able to generate an automatic sequence.
    - a. Change of binary status from 1 to 0, or 0 to 1
    - b. Reaching run-time limit
    - c. High analog alarm (adjustable, prioritized)
    - d. Low analog alarm (adjustable, prioritized)
    - e. Analog return to normal
  2. Each input point in the system shall be able to initiate a program and any number of points shall be able to initiate the same program
  3. Points initiating programs shall pass a number of parameters to the program. These parameters shall be the following:
    - a. Acronym of the point
    - b. Pointer to the point in the data base
    - c. Current status
    - d. Last value
  4. Programs shall be assigned to points through the User Interface Workstation. Assignments shall be able to be modified at any time. Time and Event Programs shall be generated at the User Interface Workstation and downloaded to local NC for execution.
  5. The operator shall be able to request a summary of all automatic sequences with point assignments. The summary shall be displayed or printed on the data logger.
- K. Duty Cycle: The operator shall be able to assign through the operator's terminal online any controlled load in the system on the duty cycle program and define associated parameters. Parameters shall be individually assigned per load.
1. Parameters shall be at least as follows:
    - a. Acronym of the load start/stop point
    - b. Acronym of the point that will feed back, (space temperature, loop temperature, differential pressure, other)
    - c. The minimum on and off times for the load required for equipment protection from damage
    - d. A description of at least one complete cycle and the time windows in which each is to be followed. At least five different cycles shall be allowed in any one day. The system shall support unique schedules for each day of the week (including holidays) and schedules do not violate the equipment's minimum on and minimum off times. Cycles shall be defined with a resolution of at least five minutes.
    - e. The operator shall be able to modify any parameter on an individual basis at any time
  2. Each load assigned to the duty cycler shall be cycled based on the individual parameters assigned to it. The duty cycler shall not stop the load if the feedback (space temperature, loop temperature, differential pressure, other) is in alarm. In no

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- case shall the load ever be on or off for less time that the minimum on or off times defined.
3. The operator shall be able to display or print all the parameters associated with a load assigned to the duty cycler on request. Summaries shall be able to be requested for all points or restricted to a particular location or load by operator choice.
  4. Loads shall be able to be locked out from or restored to the duty cycler by the operator at any time
  5. Duty cycling shall be performed by a controller using parameters downloaded from the IAS User Interface Workstation. A change of state shall be reported to the IAS User Interface Workstation Server by the controller each item the duty cycler starts or stops the load.
- L. Power Demand Monitoring and Load Shedding: The operator shall be able to assign through the operator's terminal online any controlled load in the system to the load shed program and define associated parameters. Parameters shall be individually assigned per load.
1. Parameters shall be at least as follows:
    - a. Acronym of the load start/stop point
    - b. Acronym of the point that will feed back space conditions or system status to the program [i.e., space temperature, differential pressure, light level (foot-candles), etc.]. If no space temperature point exists, this parameter shall not have to be defined.
    - c. The minimum on and off times for the load required for equipment protection from damage.
    - d. The kilowatt rating of the load.
    - e. The acronym of the electric meter that the load is associated with.
    - f. The priority level of the load. Provided capability of 16 priority levels.
  2. The operator shall be able to modify any load parameter on an individual basis at any time.
  3. The operator shall be able to display or print all of the parameters associated with the load assigned to the load shedding program on request. Summaries shall be able to be requested for all points, or restricted to a particular location or load by operator choice.
  4. Demand meters shall be defined by the operator through the operator's terminal. Parameters associated with demand meters are as follows:
    - a. Acronym of the meter
    - b. The demand limit to begin shedding loads
    - c. The demand at which loads shall begin to be restored
    - d. The number of priority level associated with the meter
    - e. The demand interval strength
  5. The operator shall be able to modify any meter parameters on an individual basis at any time
  6. The operator shall be able to display or print all parameters associated with a particular demand meter on request
  7. The power demand program shall operate on a sliding window basis. Each minute shall be considered to be in the middle of the cycle interval. The demand data shall be gathered each minute. The data from the last N minutes (where N equals one-half the interval length) shall then be used to create a best fit first-degree polynomial curve. The curve shall then be examined at what would be the end of the interval (N minutes ahead). If this value is greater than the shed limit, the power demand program shall calculate the excess load and initiate load shedding. The shedding shall begin with the lowest priority loads and shall be governed by the point's minimum on time, maximum off time, point disability, and status of the space temperature point (if one has been defined). If the point has not satisfied (continuously) its minimum on time, if the maximum off time has already been reached, if the point is disabled, or if the space temperature point is in alarm, the load initially shall not be shed. If the power demand program finds that it has examined all loads in all priorities and more

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- shedding is still necessary, according to the predicted load, it shall go back to the lowest level and re-examine the points, this time overlooking the status of space temperature points. If it is still unable to adequately reduce the load level, the operator shall be informed of the number of kilowatts still needed to be shed. Under no circumstances shall the system shed a load if the point's minimum on time has not been satisfied or if the point is disabled.
8. If at any time after load shedding has been initiated, the system forecasts the end of cycle consumption to be below the restore limit, the power demand program shall begin starting up the loads in order to bring the system back into the state in which it was operating before the shedding began. Load restoration shall be performed in inverse order from that observed in the shedding process. The first group of points to be restored shall consist of those whose sample area is in alarm. The second group shall be the remainder of the power demand monitored points that are currently off and have met their minimum off time. Under no circumstances shall the power demand program restore a point that is either disabled or has not yet satisfied its minimum off time. The starts shall be performed in an efficient manner, each being delayed by the amount of time specified by the preceding point within the same controller. When enough load has been restored so that the forecasted consumption is above the restore limit, the power demand program shall discontinue the restoration process.
  9. Points that are both duty cycled and power demand monitored may be shed by the power demand program, but shall only be started up by the duty cycler. If the duty cycler deems it necessary to start such a point, it shall determine whether the point is off due to load shedding or normal cycling. If the point was shed and an entire power demand program interval has not elapsed since the time of the shed, the duty cycler shall then locate and shed enough other load to allow the original point to be started, without affecting the total system power consumption.
  10. A power demand profile shall be available to the operator upon request. The profile shall be displayed or printed by operator selection. The profile shall include the demand meter description, the time, date, demand limit, restore limit, interval length, current demand, highest demand today and time of occurrence, highest demand yesterday and time of occurrence, highest demand during current billing period with time and date of occurrence, and the highest demand for the last 11 billing periods by billing period with time and date of occurrence, and the highest demand for the last 11 billing periods by billing period with time and date of occurrence. Billing periods shall be able to be defined by the operator through the operator's terminal.
- M. Mixed Air Enthalpy Control: The system shall calculate the enthalpy of the outside air and the return air of each air handling unit assigned to the program. The program shall use the logic required as defined in the sequence of operations.
- N. Optimum Start Time: The optimum start program shall calculate the latest start time for air handling units in each operator-defined zone. The calculations shall consider occupancy time, outdoor temperature, indoor temperature, desired indoor temperature at occupancy, the capacity of the air handler(s), and the zone's heat gain/loss rate.
1. The program shall run at a reschedule interval of no more than five minutes beginning at an hour that is certain to be before the start-up time for all of the optimum start zones. The program shall examine each zone at the frequency defined for that zone.
  2. When the program determines that the optimum start time has been reached, it shall start all of the air handling units included in the zone definition.
  3. At the zone occupancy time, the system shall record the actual zone temperature and any deviation from desired temperature. If any unit within the zone was found to have been off-line between the startup time and the occupancy time, the data shall be flagged as invalid.
  4. Optimum start zones shall be defined by the operator through the operator's terminal. Parameters shall include as a minimum:



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- a. Occupancy time for each day of the week
  - b. Desired temperature at occupancy during heating season
  - c. Desired temperature at occupancy during cooling season
  - d. Whether the zone is on cooling, heating, or both
  - e. Acronym of outdoor temperature sensor
  - f. Acronym of indoor temperature sensor
  - g. Acronym(s) of air handler(s) to be started
  - h. Acronym of the zone
5. The operator shall be able to modify the parameters at any time. A summary of the zone parameters shall be available on command. The summary shall be displayed on the operator's terminal or printed on the data logger. This summary shall detail the conditions presented to the optimum start program as well as the results of the optimum start function for one week. The information, output by zone, shall include the difference between the target temperature and both the inside and outside air temperatures at the zone start time, the difference between the target temperature and the actual room temperature at occupancy time, and the start time measured in minutes before occupancy. Performance summaries shall be able to be requested for individual or multiple zones.
- O. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow operator customization

## 2.11 GRAPHICAL USER INTERFACE SOFTWARE

- A. System Protection: A supervisory control system is used to control sensitive processes and costly equipment. Therefore, system protection is essential to prevent unauthorized actions on the system or accidental damage to the system. The following describes minimum required system protection capabilities.
1. Foreground Program Switching
    - a. It shall be possible to configure the run-time system so as to prevent the operator from obtaining direct access to foreground program switching by disabling certain keys in the system. In this way, only the foreground program switching which is built into the end application shall be accessible to the process operator.
  2. File Menu Access
    - a. It shall be possible to configure the run-time system so as to prevent the operator from obtaining direct access to the File Menu or any other direct ability to open and close files outside of the desired built-in capabilities of the final operator interface application.
  3. System Level Interface
    - a. It shall be possible to provide password protection on a moveable mask that can cover the entire system level graphical user interface, including the operating system title bars, menu bars, etc. such that only authorized personnel would have access to this level of control. This protection is necessary to prevent lesser skilled personnel from causing damage to the operator interface application, from accidentally erasing files or records, or from accessing other software not directly connected with the desired plant monitoring and supervisory control application.
  4. Operator Log-On
    - a. It shall be possible to assign each operator a log-on password which defines a unique access level, thereby limiting access to various command functions based on the operator's access level. Multiple-level password access protection shall be provided to allow the Owner's authorized IAS Administrator to limit workstation control, display and database manipulation capabilities as IAS Administrator deems appropriate for each user, based upon an assigned user name with a unique password.
    - b. Based on the operator's unique password, it shall be possible to log each operator's actions for later review.

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- c. It shall be possible to define an inactivity time span between operator actions on the system, requiring the operator to log on again with his password. This capability is useful in preventing unauthorized access to the operator interface system while an operator is away from his station performing other duties.
  - d. All passwords for the system shall be provided to the Owner including administrator, dealer, or factory level passwords for the systems provided under this Project.
  - e. Passwords shall restrict access to all Controllers.
  - f. A minimum of 250 user names shall be supported per Owner's direction.
- B. Alarm and Event Management Reporting
- 1. Alarm Display Capability:
    - a. System shall support displaying of alarms on any display as a user defined sizable object, which may be placed by itself or along with other objects in a window. It shall be possible to scroll forward or backward through the alarm displays by depressing command buttons. Current Alarms shall be available as an Alarm Summary Object and a chronological summary of Alarms shall be available as an Alarm History object.
    - b. The operator shall be able to select the alarms displayed by an object alarms by group and/or priority by using command buttons. Up to 999 priority levels shall be supported.
    - c. The system shall support an unlimited number of alarm displays.
    - d. Alarms shall be color coded according to the state of the alarm, including an acknowledged alarm, unacknowledged alarm, and an alarm that has returned to normal, but is not yet acknowledged. The user shall be able to choose from 32 different colors for display of each of these alarm states. The alarm display object may also support event display with the color used for events also being one of the 32 different colors.
    - e. The alarm display shall support the display of the following alarm parameters, which are user selectable in the configuration mode:
 

Date	Time
Type of Alarm (HIHI, LOLO, etc.)	Value of Variable in Alarm
Operator Name	Alarm Priority
Alarm Group Name	Comment
    - f. It shall be possible to configure the system such that the operator is notified of an alarm no matter what display he or she is currently viewing. Notification shall include the option of a pop-up alarm display window, a flashing process symbol, such as a process vessel, an alarm text message that is available on each display, or a dedicated alarm display window on the screen.
    - g. The user shall be able to display alarms on an individual or a group basis, with support for sixteen (16) groups, each having up to sixteen (16) subgroups. The alarm hierarchy shall be capable of being nested up to eight (8) levels deep.
    - h. It shall be possible to inform the operator of an alarm condition via an audible tone, a pop-up display, or any combination of animation types on the screen. Alarm acknowledgment may be performed on all alarms, alarms in a single group, alarms in a collection of groups as defined in an alarm group hierarchy or on a point-by-point basis.
  - 2. Alarm File Capability:
    - a. Alarms shall be logged to a file for future viewing or review of alarm history data. The user shall have the capability to review the file for cause and event analysis.
    - b. The alarms that are logged shall be configurable from a choice of the parameters.
  - 3. Alarm Printing Capability:
    - a. Alarms shall be printed to a printer using either a serial or parallel interface. The format of the alarm printout shall be configurable. All alarms shall be capable of being printed to either a local or a remote network printer.
  - 4. Alarm Transmission Capability:



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- a. Alarms shall be transmitted over the Owner's secure internal wide area network.
    - b. Each alarm shall be associated with a priority level and unique user-defined list of operator devices including any combination of local or remote workstations, printers, workstation disk files, e-mail addresses, and pagers. All alarms associated with a given priority level shall be routed to all operator devices on the user-defined list associated with that priority level. For each priority level, alarms shall be automatically routed to a default operator device in the event that alarms are unable to be routed to any operator device assigned to the priority level.
  5. Events:
    - a. Events shall be logged for review by the operator, engineering or management personnel. The system shall log each new operator log-on, and whenever an operator changes a set-point or turns any device on or off. Each time the event log records an event, it will record the operator logged in and the type of action taken (set-point change, state change, etc.), along with a date and time stamp.
- C. Real-Time and Historical Trending
1. The software shall display real-time and historical data in both a tabular and graphical format. The requirements of this trending shall include the following:
    - a. Provide trends for all physical points, virtual points and calculated variables.
    - b. In the graphical format, the trend shall plot at least four (4) different values for a given time period superimposed on the same graph. The four (4) values shall be distinguishable by using unique colors. In printed form the four (4) lines shall be distinguishable by different line symbology. Displayed trend graphs shall indicate the engineering units for each trended value.
    - c. The sample rate and data selection shall be selectable by the operator.
    - d. The trended value range shall be selectable by the operator.
    - e. Where trended values on one table/graph are COV, software shall automatically fill the trend samples between COV entries.
    - f. Real-time trend displays shall support the use of expressions of tag names including add, multiply, divide, etc., to permit proper scaling of variables.
    - g. Historical trend display should allow the user to zoom in and out in time from 1 minute up to 6 weeks in one display. It shall be possible to activate the zoom-in and zoom-out features using action scripted command buttons available to the operator.
    - h. The operator shall have the capability to pan backward and forward in time to view historically logged data.
    - i. Historically collected data shall be available to be exported to a spreadsheet format for analysis, additional reports, etc.
    - j. Control Loop Performance Trends: Controllers incorporating PID control loops shall also provide high resolution sampling in less than six second increments for verification of control loop performance.
    - k. Data Buffering and Archiving: Trend data shall be buffered at the JACE and/or CSS, and uploaded to hard disk storage when archival is desired. All archived trends shall be transmitted to the on-Site OWS or CSS as applicable. Uploads shall occur based upon a user-defined interval, manual command, or automatically when the trend buffers become full.
    - l. Time Synchronization: Provide a time master that is installed and configured to synchronize the clocks of all IAS devices supporting time synchronization. All trend sample times shall be able to be synchronized.
- D. Data Acquisition and Storage
1. All points included in the typical equipment point list must be represented in a common, open or accessible format.
  2. Data from the IAS shall be stored in a relational database format. The format and the naming convention used for storing the database files shall remain consistent across the database and across time. The relational structure shall allow for storage of any

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additional data points, which are added to the IAS in future. The metadata/schema or formal descriptions of the tables, columns, domains, and constraints shall be provided for each database.

3. The database shall allow applications to access the data while the database is running. The database shall not require shutting down in order to provide read-write access to the data. Data shall be able to be read from the database without interrupting the continuous storage of trend data being carried by the IAS.
4. The database shall be ODBC or OLE database compliant. Provide a commercially-available ODBC driver or OLE database data provider, which would allow applications to access the data via Microsoft Windows standard data access services.
5. Enterprise level data archiving shall be performed through the District's Microsoft SQL Server residing on the IAS server and XML text formats.

E. Totalization

1. The software shall support totalizing analog, digital, and pulsed inputs and be capable of accumulating, storing, and converting these totals to engineering units used in the documents. These values shall generally be accessible to the Operator Interfaces to support management-reporting functions.
2. Totalization of electricity use/demand shall allow application of totals to different rate periods, which shall be user definable.
3. When specified to provide electrical or utility Use/Demand, the Contractor shall obtain from the local utility all information required to obtain meter data, including k factors, conversion constants, and the like.

F. Equipment Scheduling

1. Provide a graphic utility for user-friendly operator interface to adjust equipment-operating schedules.
2. All operators shall be able to view the entries for a schedule. Operators with sufficient privilege shall be able to modify schedule entries from any workstation.
3. Scheduling feature shall include multiple seven-day schedules, plus holiday schedule, each with start time and stop time. Schedules shall be individually editable for each day and holiday.
4. Scheduling feature shall allow for each individual equipment unit to be assigned to one of the schedules.
5. Timed override feature shall allow an operator to temporarily change the state of scheduled equipment. An override command shall be selectable to apply to an individual unit, all units assigned to a given schedule, or to all units in a building. Timed override shall terminate at the end of an operator selectable time. A password level that does not allow assignment of schedules shall allow a timed override feature.
6. A yearly calendar feature shall allow assignment of holidays, and automatic reset of system real time clocks for transitions between daylight savings time and standard time.

G. Point Naming Convention:

1. Request IAS point naming convention from the District prior to the generation of the required IAS shop drawings.

H. User Input/Control Functions

1. Graphic software shall facilitate user-friendly interface to all aspects of the System Software specified above. The intent of this Specification is to require a graphic package that provides for intuitive operation of the systems without extensive training and experience. It shall facilitate logical and simple system interrogation, modification, configuration, and diagnosis.
2. The operator shall be able to access displays via a pointing device and/or soft key menus with a choice of function keys, cursor control keys, or any key on the keyboard. Supported pointing devices shall include a mouse, touch screen, light pen, or

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trackball.

3. The system shall support operator access to multiple displays at one time, including split screens where the operator may view more than one process area at a time. In addition, the system shall support unlimited use of pop-up displays for additional help or diagnostic information.
4. Access to all displays and to all command functions shall be based on the operator's security level to protect against unauthorized use. The security level shall be established during the operator sign-on procedure.
5. Visibility and operation of command buttons, symbols, etc. shall be controllable based upon the operator's security level.
6. The operator shall be able to have access to context sensitive help at any time during operation of the system.
7. Graphic software shall provide for multitasking such that third-party programs can be used while the OWS software is on line. Software shall provide the ability to alarm graphically even when operator is in another software package.
8. An operator shall be able to control a discrete point using an action command button. This control includes momentary on, momentary off, toggle on-off, set, and reset.
9. The operator shall be able to use command buttons to adjust set-points up and down on a percentage or absolute basis. Each request for increase or decrease shall be evaluated against valid operating limits before allowing the adjustment.
10. Control of individual set-points shall be enabled based upon a user's security level and password.

I. Display Capability

1. The software shall allow for Owner creation of user-defined, color graphic displays of geographic maps, building plans, floor plans, and mechanical and electrical system schematics. These graphics shall be capable of displaying all point information from the database including any attributes associated with each point (i.e., engineering units, etc.). In addition, operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.
2. The system shall allow the user to view animated graphics for process templates including tanks, pumps, etc. This includes:
  - a. 3 dimensional (3D) HVAC floor plans shall be produced by the IAS contractor as shown in the sample provided in Guideline A.
  - b. HVAC floor plans shall be provided with dynamic coloring and opacity by zone.
  - c. Percentage fill of the object including irregular shapes such as polygons, ellipses, etc.
  - d. Color change of the object. Up to 32 colors.
  - e. Blinking of the object based upon any alarm in the system or upon a designated group of alarms.
  - f. Each object shall have a visibility attribute option allowing for visibility of the object based upon a condition in the system.
  - g. The system shall support animation of objects via resizing, moving, and/or rotating objects based upon a change in a process variable.
  - h. Objects shall be animated based upon any user-defined criteria made up of other tag-names in the system. This includes the use of expressions containing all mathematical functions and the status of analog and discrete values in the system.
  - i. Objects shall be able to be animated according to any of eight (8) different alarm conditions for an analog variable, including:
 

Lo Alarm	LoLo Alarm
Hi Alarm	HiHi Alarm
  - j. Rate of Change Normal State
  - k. Objects shall be able to blink or change color by evaluating any of the 32 bits in an analog register. Up to 32 colors shall be possible.
3. The system shall support the capability for the operator to view scanned images from desktop or hand-held scanners. It shall be possible to animate these images to show

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- a color change based on the status of process operations, including alarm or normal state.
4. Screen Penetration: The operator interface shall allow users to access the various system graphic screens via a graphical penetration scheme by using the mouse to select from menus or 'button' icons. Each graphic screen shall be capable of having a unique list of other graphic screens that are directly linked through the selection of a menu item or button icon.
  5. Dynamic Data Displays: Dynamic physical point values shall automatically updated at a minimum frequency of six (6) updates per minute without operator intervention. Point value fields shall be displayed with a color code depicting normal, abnormal, override and alarm conditions.
  6. Point Override Feature: Each displayed point shall be individually enabled/disabled to allow mouse-driven override of digital points or changing of analog points. Such overrides or changes shall occur in the control unit, not just in the workstation software. The graphic point override feature shall be subject to password level protection. Points that are overridden shall be recorded as an event, and shall be displayed in a coded color. The event message shall include the operator's user name.
  7. System shall support use of true-type scalable fonts that may be scaled according to the desired size of the text. The fonts shall be loaded by the operating system. The user may choose from up to 32 different text colors.
  8. System shall support change of text color based upon the process value going into eight (8) different alarm states.
  9. Text shall be able to blink based upon any user definable condition occurring in the system, such as an alarm on a particular setpoint, alarm on any value in a process group, or based on the actual value of a process variable.
  10. System shall display process values based upon the security level of the user.
  11. Text shall be able to be made visible or invisible based upon an alarm condition in the process or any other state change in the system.
  12. Graphics Development Package: Graphic development and generation software shall be provided to allow the user to add, modify, or delete system graphic displays.
  13. The Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), mechanical system components (e.g., pumps, chillers, cooling towers, boilers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols.
  14. The Graphic Development Package shall use a mouse or similar pointing device to allow the user to perform the following:
    - a. Define symbols.
    - b. Position items on graphic screens.
    - c. Attach physical or virtual points to a graphic.
    - d. Define background screens.
    - e. Define connecting lines and curves.
    - f. Locate, orient and size descriptive text.
    - g. Define and display colors for all elements.
    - h. Establish correlation between symbols or text and associated system points or other displays.
    - i. Create hot spots or link triggers to other graphic displays or other functions in the software.

## **PART 3 EXECUTION**

### **3.1 SYSTEM CONFIGURATION**

- A. Contractor shall thoroughly and completely configure IAS system software, supplemental

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software, network communications, CSS, OWS, remote operator workstations, portable operator's terminal, printer, and network communications.

- B. Contractor shall, after all hardware (devices / nodes and wiring) has been installed, provide all necessary device installation, device configuration, device programming, device diagnostics, network variable binding, alarm management and systems diagnostics. The contractor shall also provide the software tools necessary to perform these services. The software tools shall be registered to the owner.
- C. Utilize a protocol analyzer tool to monitor network traffic on all installed DLN control channels for a minimum of 24 hours per channel. Furnish additional hardware and/or reconfigure nodes as necessary to maintain traffic to at least 50% of channel bandwidth capacity or a maximum of 70% of the available resources in the Niagara controller.
- D. Contractor shall start-up, test, and set all parameters. The Contractor shall demonstrate compliance with all requirements herein. All damaged or malfunctioning software/hardware shall be replaced.
- E. Final adjustments shall be performed by specially trained personnel in the direct employment of the Contractor.
  - 1. All graphics and alarm monitoring shall be operational and demonstrated before final acceptance

### **3.2 SITE-SPECIFIC APPLICATION PROGRAMMING**

- A. Provide all database creation and Site-specific application control programming as required by these Specifications, national and local standards and for a fully functioning system. Provide Site-specific application programming and thoroughly document programming. Meet the intent of the written sequence of operation. It is the Contractor's responsibility to request clarification on sequence issues.
- B. All Site-specific programming shall be fully documented and submitted for review and approval, prior to downloading into the panel, at the completion of functional performance testing, and at the end of the Warranty Period.
- C. All programming, graphics and data files must be maintained in a logical system of directories. All file names shall adhere to the naming convention format as established in the Owner's Standard Acronyms documentation. All software applications, programs, databases and files developed for the Project will be the property of the Owner, will be licensed to the Owner and shall remain on the workstation(s)/server(s) at the completion of the Project.
- D. All application programming shall be performed on-site at the district's Oceanside campus. Remote access for application programming shall not be provided.

### **3.3 PASSWORD SETUP**

- A. Follow District Standard password setup schemes.

### **3.4 POINT PARAMETERS**

- A. Provide the following minimum programming for each analog input:
  - 1. Name
  - 2. Address
  - 3. Scanning frequency or COV threshold

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4. Engineering units
  5. Offset calibration and scaling factor for engineering units
  6. High and low alarm values and alarm differentials for return to normal condition
  7. High and low value reporting limits (reasonableness values), which shall prevent control logic from using shorted or open circuit values
  8. Selectable averaging function that shall average the measured value over a user selected number of scans for reporting
- B. Provide the following minimum programming for each analog output:
1. Name
  2. Address
  3. Output updating frequency
  4. Engineering units
  5. Offset calibration and scaling factor for engineering units
  6. Output Range
7. Provide the following minimum programming for each digital input:
8. Name
  9. Address
  10. Engineering units (on/off, open/closed, freeze/normal, etc.)
  11. Debounce time delay
  12. Message and alarm reporting as specified
  13. Reporting of each change of state, and memory storage of the time of the last change of state
  14. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions
- C. Provide the following minimum programming for each digital output:
1. Name
  2. Address
  3. Output updating frequency
  4. Engineering units (on/off, open/closed, freeze/normal, etc.)
  5. Direct or Reverse action selection
  6. Minimum on-time
  7. Minimum off-time
  8. Status association with a DI and failure alarming (as applicable)
  9. Reporting of each change of state, and memory storage of the time of the last change of state
  10. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions

### 3.5 HISTORICAL DATA LOGGING

- A. Historical data logging shall be configured and located in the Niagara 4 JACE and archived in the Niagara 4 Supervisor per the owner's requirements.
- B. Archival of the trend logs shall be based on time of day. Stagger archival of each campus JACE so that no two JACE network supervisors ever archive to the server at the same time.
- C. Contractor shall establish and store trend logs. All points shown on the IAS drawings shall be trended at a minimum 15 minute interval for a period of 1 year before being overridden. All associated setpoints shall be trended as well. Fixed setpoints may be trended with change-of-value (COV) intervals. Setpoints with resets shall be trended at 15 minute intervals.
- D. The Owner will analyze trend logs of the system operating parameters to evaluate normal system functionality. Contractor shall establish these trends and ensure they are being



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stored properly.

- E. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field or single date stamp. Recorded parameters for a given piece of equipment or component shall be trended at the same intervals and be presented in a maximum of two separate 2-dimensional formats with time being the row heading and field name being the column heading.
- F. Sample times indicated as COV ( $\pm$ ) or change-of-value mean that the changed parameter only needs to be recorded after the value changes by the amount listed. When output to the trending file, the latest recorded value shall be listed with any given time increment record. The samples shall be filled with the latest values also if the points include different time intervals.
- G. Trending intervals or COV thresholds shall be dictated by the Owner upon system start-up.
- H. The Contractor shall demonstrate functional trends as specified for a period of 30 days after successful system demonstration before final acceptance of the system.

### 3.6 TREND GRAPHS

- A. Prepare controller and workstation software to display graphical format trends. Trended values and intervals shall be the same as those specified.
- B. Lines shall be labeled and shall be distinguishable from each other by using either different line types, or different line colors.
- C. Indicate engineering units of the y-axis values; e.g. degrees F., inches w.g., Btu/lb, percent open, etc.
- D. The y-axis scale shall be chosen so that all trended values are in a readable range.
- E. Trend outside air temperature, humidity, and enthalpy during each period in which any other points are trended.
- F. All points trended for one HVAC subsystem (e.g. air handling unit, chilled water system, etc.) shall be trended during the same trend period.
- G. Each graph shall be clearly labeled with variables, date, and times.

### 3.7 ALARMS

- A. The IAS Provider is required to submit a point summary to confirm point names as specified herein. The IAS Provider shall submit this point summary with the addition of identifying all alarms which includes detail information on the alarm parameters to the Owner for approval prior to the beginning of any Commissioning process of the integrated automation system.
- B. The Owner shall grant approval of alarms by issuing the approved alarms to the Contractor. The approved alarms issued to the Contractor shall be used for the Functional Test Procedures alarms tested. The Contractor shall initiate the start of this process immediately after IAS submittal has been approved and monitor the progress to ensure the construction schedule is not delayed.
- C. Analog Input Alarms:
  - 1. Duct Static Pressure:

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- a. Alarm @  $\pm$  0.3 inches from set point for 5 minutes @ Priority 3
  - b. Normal @  $\pm$  0.2 inches from set point for 5 minutes
  - c. Alarm is active after fan is proven ON for the minimum time necessary to allow the sensor to be within the alarm parameter
  - d. Alarm is deactivated after fan is proven OFF
  2. Duct Air Temperatures:
    - a. Alarm @  $\pm$  2.0 degrees F from set point for 5 minutes @ Priority 3
    - b. Normal @  $\pm$  1.0 degrees F from set point for 5 minutes
    - c. Alarm is active after fan is proven ON for the minimum time necessary to allow the sensor to be within the alarm parameter
    - d. Alarm is deactivated after fan is proven OFF
  3. Space or Room Temperature:
    - a. Submit as not alarmable and Owner will confirm
  4. Duct or Space Humidity:
    - b. Alarm @ (+) 15 percent from set point (60 percent) for 5 minutes at Priority 3
    - c. Alarm @ (-) 20 percent from set point (60 percent) for 5 minutes at Priority 3
    - d. Normal @ 5 percent from offset alarm parameters for 5 minutes
    - e. Point is always ready to alarm.
  5. Water temperature sensors which are inputs to control loops:
    - a. Submit reasonable alarm parameter to prevent nuisance alarming at Priority 3.
    - b. Owner will confirm alarm.
  6. All other Analog Inputs:
    - a. IAS Provider shall utilize their expertise and recommend not less than three (3) analog input alarms which protect the Owner's best interests.
    - b. Submit at Priority 3 with recommended alarm parameters.
    - c. Identify recommended alarms in submittal.
    - d. Owner will confirm alarm.
- D. Digital Input Alarms:
1. Proofs (current sensor, air flow switches, water differential pressure switches etc).
    - a. Digital inputs paired with BAS digital output will have the ability to alarm at all times at Priority 3.
    - b. Alarm will delay for the reason time needed when the state of the digital output changes to prevent nuisance alarms
    - c. Point is in alarmed condition when the value of the digital input does not equal the value of the digital output after the time delay
    - d. Point is in the Normal condition when the value of the digital input equals the value of the digital output after the time delay
    - e. Digital input proofs without a paired digital output shall not alarm and be for monitoring purposes only.
  2. Safeties (high static cutout, freeze condition, excessive vibration, high humidity cutout, VFD fault, etc.).
    - a. The digital input shall be always ready to alarm without delay
    - b. The digital input shall display "ALARM" at Priority 3 at the Alarm screen when activated.
    - c. The digital input shall display "NORMAL" at the Alarm screen when deactivated.
  3. Monitoring Digital Inputs (auxiliary drain pan alarm, Unit general alarm, water detector, etc) the exception is air filter differential pressure switch.
    - a. All digital inputs which "deactivated" is the normal state of planned operations shall alarm when the normal state of planned operation changes
    - b. The digital input shall display "ALARM" at Priority 3 at the Alarm screen when activated
    - c. The digital input shall display "NORMAL" at the Alarm screen when deactivated
  4. Air Filters:
    - a. Submit as not alarmable and Owner will confirm.
    - b. The digital input shall display "DIRTY" when activated.



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- c. The digital input shall display "CLEAN" when deactivated
- E. Analog Output Alarms:
  - 1. All Analog Outputs:
    - a. IAS Provider shall utilize their expertise and recommend any analog output alarms which protect the Owner's best interests.
    - b. Identify recommended alarms in submittal.
    - c. Owner will confirm any alarms.
- F. Digital Output Alarms:
  - 1. Refer to digital inputs paired with digital outputs as specified herein.
  - 2. All Digital Outputs:
    - a. IAS Provider shall utilize their expertise and recommend any digital output alarms which protect the Owner's best interests.
    - b. Identify recommended alarms in submittal.
    - c. Owner will confirm any alarms.
- G. Nuisance Alarms: All alarms which have been identified by the Owner as a nuisance alarm due to numerous times in and out of alarm, shall be addressed and corrected by the Contractor in a manner that the Owner has approved.
- H. See requirements for additional equipment-specific alarms specified in the Contract Documents.

### 3.8 GRAPHIC SCREENS

- A. The general look, feel and functionality of the interface has been established for all equipment and functions included in the scope of work. The Contractor shall review the existing graphic standards in terms of visual appearance and functionality and shall generate a GUI which is in full compliance with the look and functionality defined in the standards. The Owner shall be the final authority for system compliance with this requirement.
- B. The Contractor shall use identical graphics, features and logic from the Graphics Requirement Exhibit standards to replicate new system graphics for the GUI development.
- C. For systems which do not have existing graphics standards the Contractor shall generate new graphics which are similar in nature, look and function to the Niagara 4 Graphics Requirement Exhibit Document. The Contractor shall submit all graphics to the Owner and engineer for approval prior to replicating for each piece of equipment.
- D. The Contractor shall provide graphs, trends, logs and system links for all components as defined in these design documents.
- E. The Contractor shall develop the GUI in accordance with all rules and guidelines for development as set by the manufacturer. This shall include following all guidelines for bundles, nested bundles, interstation links, network management, and the rules and guidelines defined by Tridium.
- F. The Contractor shall develop individual graphics and web pages for the following system components. Actual Design Document Revit or BIM files for risers, floor plans and details may be incorporated into the GUI development if acceptable to the project Engineer and the District. Contact the Owner and sign required waivers to gain access to these files.
  - 1. Provide graphic floor plan screens for each floor of each building.
    - a. The contractor shall develop three-dimensional floor plans for each floor for use on the HVAC floor plan controls. The floor plans shall be generated using AutoCAD

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- 3DMax or equal, and shall match the style of the exiting graphical user interface.
  - b. Indicate the location of all equipment that is not located on the equipment room screens.
  - c. Indicate the location of temperature sensors associated with each temperature-controlled zone (i.e., VAV terminals, fan-coils, single-zone AHUs, etc.) on the floor plan screens.
  - d. The IAS contractor shall configure the system to provide the user with a minimum of 4 options to view the HVAC floor plans:
    - 1) Dynamic gradient color/opacity by zone temperature (more blue for cold and more red for hot).
    - 2) Dynamic gradient color / opacity by zone temperature offset from setpoint (more blue for below setpoint and more red for above setpoint).
    - 3) Dynamic gradient color/opacity by zone heating cooling demand.
    - 4) Dynamic gradient color / opacity by zone occupancy (more opaque for zones with longer occupied states; less opaque for zones with shorter occupied states).
  - e. Include a spectrum legend and any global HVAC floor commands.
  - f. Display the space temperature point adjacent to each temperature sensor symbol. Use a distinct line symbol to demarcate each terminal unit zone boundary. Use distinct colors to demarcate each air handling unit zone.
  - g. Mechanical floor plan Drawings will be made available to the Contractor upon request for the purpose of determining zone boundaries. Indicate room numbers as provided by the Owner.
  - h. Provide a drawing link from each space temperature sensor symbol and equipment symbol shown on the floor plan graphic screens to each corresponding equipment schematic graphic screen.
  2. Provide graphic floor plan screens for each mechanical equipment room. Indicate the location of each item of mechanical equipment. Provide a drawing link from each equipment symbol shown on the graphic plan view screen to each corresponding mechanical system schematic graphic screen.
  3. If multiple floor plans are necessary to show all areas, provide a graphic building key plan. Use elevation views and/or plan views as necessary to graphically indicate the location of all of the larger scale floor plans. Link graphic building key plan to larger scale partial floor plans. Provide links from each larger scale graphic floor plan screen to the building key plan and to each of the other graphic floor plan screens.
  4. Provide a graphic Site plan with links to and from each building plan.
- G. System Schematic Screens: Provide graphic system schematic screen for each subsystem controlled with each I/O point in the Project appearing on at least one graphic screen. System graphics shall include flow diagrams with status, setpoints, current analog input and output values, operator commands, etc. as applicable. General layout of the system shall be schematically correct. Input/output devices shall be shown in their schematically correct locations. Include appropriate engineering units for each displayed point value. Verbose names (English language descriptors) shall be included for each point on all graphics; this may be accomplished by the use of a pop-up window accessed by selecting the displayed point with the mouse. Indicate all adjustable setpoints on the applicable system schematic graphic screen or, if space does not allow, on a supplemental linked-setpoint screen.
- H. Provide graphic screens for each AHU. Indicate outside air temperature and enthalpy, and mode of operation as applicable (i.e., occupied, unoccupied, warm-up, cool-down). Link screens for air handlers to the heating system and cooling system graphics. Link screens for supply and exhaust systems if they are not combined onto one screen.
- I. Use Toolbar at top of each screen page to provide equipment information, Server Time/Date, OAT, OARH, Chiller Temp, and to provide hyperlink access to Alarms, Charts, Calendar, Emergency Stop.

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- J. Provide a graphic screen for each zone. Provide links to graphic system schematic screens of air handling units that serve the corresponding zone.
- K. Provide summary graphics for multiple zones for each floor (e.g. VAV zones).
  - 1. Columns in the Summary shall indicate VAV Name, Space Temp, Setpoint, Occupied Mode, Heat Setpoint, Cool Setpoint, Actual Airflow, Max Airflow Setpoint, Cooling Damper Percent, Minimum Airflow Setpoint, and Heating Damper Percent.
  - 2. Rows in the Summary shall indicate the data from a single VAV box
  - 3. Each row shall be overlaid with a hyperlink to the individual VAV Box Graphic
  - 4. Each row shall include a background which will turn red upon any VAV alarm, thus serving as an alarm summary page
  - 5. Each row shall include a background which will turn yellow upon any VAV parameter placed in Override, thus serving as a reminder to return parameters to Automatic
  - 6. The Menu shall allow direct hyperlink to this graphic from "Floors / Floor XX / Area Summary" item>
  - 7. Link screens for heating and cooling system graphics to utility history reports showing current and monthly electric uses, demands, peak values, and other pertinent values.
  - 8. Individual Power Meter Graphic
    - a. Provide detailed metering page for each power meter installed as part of this project. Classify these per floor.
    - b. Each page shall indicate power meter status, voltage, amperage, power, energy, demand, and power factor for each phase of each meter.
    - c. Meets ANSI C12.20 Accuracy Standard
    - d. Each of these components shall be logged, with Chart buttons provided for fast hyperlink to associated log chart.
    - e. The Menu shall allow direct hyperlink to this graphic.>
  - 9. Provide graphic animation for the following objects:
    - a. Damper position
    - b. Fan status
    - c. Cooling and Heating Coils
    - d. Lighting zones
- L. Alarms: Each programmed alarm shall appear on at least one graphic screen. In general, alarms shall be displayed on the graphic system schematic screen for the system that the alarm is associated with (for example, chiller alarm shall be shown on graphic cooling system schematic screen). For all graphic screens, display analog values that are in a 'high alarm' condition in a red color, 'low alarm' condition in a yellow color. Indicate digital values that are in alarm condition in a red color.

**END OF SECTION 25 15 00**

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## **SECTION 25 95 00**

### **INTEGRATED AUTOMATION CONTROL SEQUENCES FOR HVAC**

#### **PART 1 GENERAL**

##### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

##### **1.2 SUMMARY**

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

##### **1.3 DEFINITIONS**

- A. CAV: Constant Air Volume.
- B. DDC: Direct-Digital Controls.
- C. VAV: Variable Air Volume.
- D. VFD: Variable Frequency Drive
- E. CHW: Chilled Water
- F. CW: Condenser Water
- G. HHW: Heating Hot Water

##### **1.4 SUBMITTALS**

- A. Sequence of Operations
  - 1. Provide a final sequence of operations based on the design intent described herein. Sequences shall include all software interlocks, alarms, safeties, and delays.

##### **1.5 GENERAL**

- A. Equipment start stop and Software Interlocks
  - 1. Mechanical equipment shall be operated, controlled and monitored by the DDC system using the input/output (I/O) shown on the drawings. The operation of the equipment shall be subject to the operational modes, conditions and logic described in this Section. A time delay shall be initiated on system command for equipment start to allow status feedback devices to actuate. At the expiration of the time delay, absence of the run status input signal, which indicates a failure to start or to continue to run, shall cause the system to alarm and start standby units as required. The system shall not restart until commanded to "return to normal". Alarms assigned to analog inputs shall be delayed on equipment startup to allow sufficient time for equipment capacity to bring the process variable values within the normal range.

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- Variable capacity fans shall always start in an "unloaded" condition.
- 2. HAND-OFF-AUTO switches shall be monitored to generate a critical alarm (an alarm that must be acknowledged) when the switch is indexed out of the "AUTO" position.
- 3. Supply air, return air and exhaust air fans serving the same spaces shall be interlocked by means of software.
- 4. Whenever equipment is put into operation automatically, the DDC control loops shall be activated. When equipment is not operating, control loops shall be deactivated and end elements shall go to their normally open or normally closed positions as shown on the contract drawings unless otherwise specified.

B. Equipment Staging and Rotation

- 1. Parallel devices shall be lead/lag rotated to maintain even wear.
- 2. Two runtime points shall be defined for each device:
  - a. Lifetime Runtime: The cumulative runtime of the device since device start-up. This point shall not be readily resettable by operators.
  - b. Staging Runtime: An operator resettable runtime point that stores cumulative runtime since the last operator reset.
- 3. Lead/lag devices: Unless otherwise noted, parallel staged devices (such as CHW pumps and cooling towers) shall be lead/lag alternated when more than one is off or more than one is on so that the device with the most operating hours as determined by Staging Runtime is made the last stage device and the one with the least number of hours is made the lead stage device.
- 4. Exceptions to Lead/lag and Lead/standby rotation
  - a. Operators with appropriate access level shall be able to manually command staging order via software points, but not overriding the In Alarm or Hand Operation logic below.
- 5. Alarming Devices: If the lead device has a fault condition, a Level 2 alarm shall be generated and a response shall be triggered as defined below.

C. Alarm conditions shall be as follows:

- 1. Fans and Pumps
  - a. Status point not matching it's on/off point for 3 seconds after a time delay of 15 seconds when device is commanded on
- 2. Boilers
  - a. Shutdown alarm condition either through network or hardwired alarm contact, or
  - b. HW isolation valve feedback indicates valve is not open 90 seconds after device is commanded open, or
  - c. If it's leaving water temperature remains 15°F below setpoint for 15 minutes
- 3. Upon identification of a fault condition:
- 4. For pumps:
  - a. The next commanded OFF device in the staging order, Device "B", shall be commanded ON while alarming Device "A" remains commanded ON.
  - b. If Device B fails to prove status (i.e. it also goes into alarm), it shall remain commanded on and the preceding step shall be repeated until the quantity of devices called for by the lead/lag logic have proven on.
  - c. When either the required number of devices proves on or all devices are commanded on, set alarming devices to the last positions in the lead/lag staging order sequenced reverse chronologically (i.e. the device that alarmed most recently is sent to last position).
  - d. Staging order of non-alarming devices shall follow the even wear logic. A device in alarm can only automatically move up in the staging order if another device goes into alarm.
    - 1) Devices in alarm shall run if so called for by the lead/lag staging order and present stage.

D. Control of Damper, Valve, and Fan Speed

- 1. The DDC system shall apply P, PI or PID control by modulating analog outputs to the

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- actuators in the proper direction to control temperature, humidity, pressure, flow and other process variables as specified.
- 2. All control and alarm setpoints shall be adjustable by the operator. Initial setting of all control and alarm setpoints shall be performed by the DDC system Contractor.

E. DDC System Failure

- 1. If Remote Control Panels (RCPs or ACPs) should fail, the operating equipment controlled by that panel shall continue to function, based on the last command.

## 1.6 WATER SOURCE HEAT PUMP (WSHP) UNIT CONTROL

- A. Scheduling: The water source heat pump system will be enabled based on a time-of-day (TOD) schedule and system demand as indicated by zone thermostat or as programmed by the building operator. System operation shall be allowed at all times.
- B. Modes of Operation: Occupancy for systems serving zones scheduled through the 25 Live scheduling software shall be overridden by the network scheduling software for HVAC
  - 1. Occupied Mode: During Occupied Mode, enable operation of heat pump units and the condenser water plant and open the WSHP isolation valve. The reversing valve and DX compressors shall be staged as required to maintain the space temperature heating and cooling setpoints (adj.). The supply fan shall run continuously.
  - 2. Unoccupied Mode: During Unoccupied Mode, disable operation of heat pump units and the condenser water plant and close the WSHP isolation valve. The WSHP shall cycle on to maintain the unoccupied space temperature setback heating and cooling setpoints (adj.). When a wall sensor override button is depressed during unoccupied period, operate the system in occupied mode for one hour (adj.).
  - 3. Optimal Start Warm-up Mode: Base the warm-up start time on an optimal start strategy calculated using outdoor air temperature and average zone temperature. If the average zone temperature is less than 69°F (adjustable), initiate the warm-up mode and set the Warm-up Mode Low Temperature Setpoint to 70°F (adjustable). Enable the water loop pumps, the boilers, and the boiler pumps. Once water loop is proved, enable the heat pump unit(s), as required, to operate in heating mode. Disable fluid coolers during warm-up mode. Terminate warm-up mode when the average zone temperature rises above the Warm-up Mode Low Temperature Setpoint.
  - 4. Demand Shed: Upon receipt of a demand shed signal, all non-critical zones shall reset their heating setpoint down by 4°F and their cooling setpoint up by 4°F. The demand shed mode shall be manually enabled or disabled by an operator button on the graphical user interface as well as by an automatic campus signal.
- C. DX Cycle Control: Incorporate compressor minimum on time, compressor minimum off time, and compressor on/off delays for periods recommended by the WSHP manufacturer.
- D. Operator Station Display: Indicate the following on operator workstation display terminal (minimum requirements):
  - 1. System graphic(s) – provide one graphic for each WSHP.
    - a. WSHP mode.
    - b. 25Live Occupancy Command
    - c. Reversing valve position.
    - d. WSHP fan command
    - e. WSHP fan status.
    - f. Mixed air temperature
    - g. Supply air temperature.
    - h. Room temperature and setpoints.
    - i. Occupancy sensor status (where provided)
    - j. All alarms.

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## 1.7 CONDENSER WATER PLANT CONTROL

- A. The condenser water system will be enabled based on a time-of-day (TOD) schedule and system demand as indicated by WSHP operation or as programmed by the building operator. System operation shall be allowed at all times.
- B. Condenser Water Pump Control: When the condenser water loop is enabled, the DDC system shall start the lead condenser water pump.
  - 1. A failure of the lead CW pump shall cause the lag pump to start and an alarm condition shall be indicated at the building operator's terminal.
  - 2. The CW pumps shall rotate lead/lag status on a monthly basis, or as programmed by the building operator.
  - 3. If the CW flow switch signal does not match CW pump command, generate an alarm at the operator workstation.
- C. Condenser Water Cooling Control: The condenser water system operates using the manufacturer provided controller. The controllers shall be integrated into the building management system.
  - 1. When the condenser water loop is enabled, the IAS system shall enable the fluid cooler through a hardwired control point. The fluid cooler shall remain enabled with the condenser water loop.
  - 2. The IAS system shall set the condenser water cooling setpoint through it's BACnet point "Fluid Temp Setpoint." The setpoint shall initially be set to 80 F.
  - 3. The IAS system shall command the preconfigured operating mode of the fluid cooler during operation through it's BACnet point "Operation Mode." The operation mode shall initially be set to "Energy Saver."
  - 4. Manufacturer's description of "Energy Saver" mode: *"During periods when ambient temperatures or load from the building or process are relatively high, the Nexus Modular Hybrid Cooler operates with all spray system active across all modules. During off-design conditions, The EC Fan System will automatically and intelligently reduce speed whenever possible. As the load is satisfied, the fans and spray pumps will cycle off. When demand increases and calls for heat rejection, each module turns on in sequence. Once all modules are turned on, all fans operate at a synchronized speed."*
  - 5. If the water loop temperature exceeds a CW high limit of 100° F, generate an alarm at the operator workstation and reset all active control loops.
- D. Condenser Water Heating Control:
  - 1. If the condenser water drops 5° F (adj.) below the condenser water heating setpoint (67°F adj) for a period of 15 minutes (adj.) enable the boiler.
  - 2. Upon proof of pump operation as indicated by the current sensing relay and sufficient CW flow as indicated by the boiler's flow switch, enable the boiler's controller for operation.
  - 3. The boiler shall operate under its own internal controls to maintain the condenser water heating setpoint. This set point shall be set by the building operator via the DDC system.
  - 4. If the condenser water temperature rises 5° F (adj.) above the condenser water heating setpoint for a period of 15 minutes (adj.), disable the boiler's controller.
  - 5. Appropriate time delays shall be utilized between each step per the boiler manufacturer's recommended time intervals.
  - 6. If the water loop temperature exceeds a CW low limit of 58° F, generate an alarm at the operator workstation and reset all active control loops.
- E. Safeties:
  - 1. Disable the fluid cooler's pump if the water level in the fluid cooler's basin falls below its minimum allowable level. Initiate a Low Water Basin Alarm at the BAS operator

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- workstation.
  - 2. Disable the fluid cooler upon a signal from the vibration switch.
  - 3. Disable the condenser water system and generate an alarm at the BAS operator workstation if the CW pump status is on and the cooling tower flow switch indicates no flow for a period of 3 minutes.
- F. Operator Station Display: Indicate the following on operator workstation display terminal (minimum requirements):
- 1. System graphic(s) – provide one graphic for condenser water system overview.
    - a. Outside air dry bulb temperature
    - b. Outside air wet bulb temperature
    - c. Outside air dew point (Calculated)
    - d. Condenser water supply heating/cooling temperature setpoints
    - e. Condenser water supply temperature
    - f. Condenser water return temperature
    - g. CW pump status
    - h. CW pump command
    - i. CW pump Run time (hours and thousands of hours)
    - j. Boiler command
    - k. Boiler alarm
    - l. All Alarms.
  - 2. Fluid Cooler BACnet points to display in the main CW system graphic:
    - a. Operating Mode (read/write)
    - b. Fluid Temperature Setpoint (read/write)
    - c. Unit Status (read)
    - d. Pump Status (read)
    - e. VFD run status
    - f. Fan Speed (read)
    - g. Frequency (%)
    - h. Actual Speed- dry/wet (RPM)
  - 3. Fluid Cooler BACnet points to display in the CW system table page(typ.) graphic:
    - a. Pump Fault (read)
    - b. Leaving water temperature high message (read)
    - c. Leaving water temperature low message (read)
    - d. Water high level message (read)
    - e. Water low level message (read)
    - f. Alarm Reset (read/write)
    - g. Conductivity Sensor (read)
    - h. Fan Status (read)
    - i. Common Alarm Fan (read)
    - j. Modules Operating (wet) (read)
    - k. Modules Operating (dry) (read)
    - l. Conductivity Setpoint (read/write)
    - m. Conductivity Differential Setpoint (read/write)
    - n. Water Management Time Bleed Enable (read/write)
    - o. Water Management Time Drain Enable (read/write)
    - p. Alarm Reset (read/write)
    - q. Cold Weather Active (read)
    - r. Single Cell Critical Message (read)
    - s. Motor Input Power- dry/wet (kW)
    - t. All Alarms – r

## 1.8 (E) EXHAUST FANS 3 AND 5 THRU 9 AND NEW EXHAUST FAN 10

- A. Provide DDC control using electric actuation.



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- B. The exhaust fan shall be logically interlocked to run when its associated water source heat pump unit is enabled.
- C. Safety:
  - 1. The DDC system shall use a current sensing relay to monitor the fan status.
- D. Operator Station Display: Indicate the following on operator workstation display terminal (minimum requirements):
  - 1. System graphic(s).
    - a. Exhaust fan on-off indication, run status, and alarms.

## 1.9 (E) KITCHEN MAKEUP AIR UNIT AND EXHAUST FANS 1 AND 2

- A. The makeup air unit is locally controlled through a wall switch and EF1 & EF 2 are electrically interlocked to run when the makeup air unit is enabled.
- B. A current sensing device on the makeup air unit detects system operation for monitoring purpose only.
- C. Safety:
  - 1. The DDC system shall use a current sensing relay to monitor the MAU status.
- D. Operator Station Display: Indicate the following on operator workstation display terminal (minimum requirements):
  - 1. System graphic(s).
    - a. Makeup Air Unit and EF-1/2 Status.

## 1.10 IDF ROOM REMOTE MONITORING

- A. The IDF Room has an existing DX split system which operates independent of the IAS system. Provide an IAS room temperature sensor for remote monitoring and alarm.
- B. Safety:
  - 1. The DDC system shall send a priority alarm if the IDF room temperature exceeds 90 F (adjustable).
- C. Operator Station Display: Indicate the following on operator workstation display terminal (minimum requirements):
  - 1. System graphic(s).
    - a. IDF Room Temperature and Alarm Setpoint.

## 1.11 UTILITY METERING

- A. Operator Station Display: Indicate the following on operator workstation display terminal (minimum requirements):
  - 1. Provide a dedicated utility metering GUI dashboard page for the building.
    - a. Instantaneous domestic water usage (gallons per minute)
    - b. Instantaneous natural gas usage (MBH)
    - c. Instantaneous electrical usage (kW)
    - d. Integrated electrical meter points (display on a drill down or pop up)
      - 1) Current per phase (amp)
      - 2) Power factor
      - 3) Reactive power (kVAR)

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- 4) Apparent power (kVA)
  - 5) Real power (kW)
2. Combined building energy consumption based on the addition of electricity and natural gas. Convert all utility consumption to BTU's.
3. Provide a stacked area graph to view the historic consumption of each utility. Provide area stacked graphs with gradient transparency. Line graphs are not acceptable.
4. Allow the user to select the historical utility usage type to view. Historic utility usage type options shall include natural gas, electrical, water, and combined energy consumption.
5. Allow the user to select the period to view. At a minimum, the choices shall include; today, yesterday, last week, last year, or a user selected time period.
6. Provide an optional line overlay to compare previous time period energy consumption to the current selection. The previous time period shall be identical to the selected time period.
7. For the combined electrical utility, provide a stacked area graph view which shows the contribution of each electrical submeter to the whole. Refer to electrical sheets E0.1 and E6.02 for an electrical single line and panel schedule which shows the service of each submeter. Provide at a minimum the following sub metered categories.
  - a. Whole building electrical meter
  - b. Single panel electrical use; in the stacked graphs, deduct electrical use of subpanels from the main panel electrical use.
8. Show an energy use intensity (EUI) table which displays the following EUI's based on the most recent 12 months of complete usage history.
  - a. Combined building EUI (BTU/SF-YR)
  - b. Electrical use index (kWh/SF-YR)
  - c. Natural gas use index (BTU/SF-YR)
  - d. Water use index (Gal/SF-YR)

## 1.12 TRENDING

1. Provide trend collection on all physical DDC points specified. Establish trend collection intervals of 15 minutes for specified points. Provide trend data collection capacity to store up to 365 days' worth of data for all specified points.

## PART 2 PRODUCTS (NOT APPLICABLE)

## PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION 25 95 00

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## **SECTION 26 00 00 GENERAL ELECTRICAL REQUIREMENTS**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 SCOPE**

- A. Basic electrical requirements specifically applicable to Division 26 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 provide complete and operational electrical systems including:
    - a. All temporary construction power including test power, temporary heat and lighting;
    - b. Incidental items not indicated on the drawings nor mentioned in the Specifications that belong to the work described, or are required to provide complete and operable systems, as though called out here in every detail;
    - c. Cleaning, cutting, patching, repairing and painting;
    - d. Testing and commissioning;
    - e. The Contractor shall coordinate this Section with all other Sections of the Specification.

#### **1.03 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 workmanlike 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. In the event of a conflict or inconsistency between items indicated on the plans and/or specifications or with code requirements, the note, specification or code which prescribes and establishes the more complete job, or the higher standard prevail.
- D. 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.
- E. For purposes of clearness and legibility, the electrical drawings are essentially diagrammatic. The size and location of equipment is shown to scale where possible. The contractor shall verify all

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conditions, data information as indicated on the drawings and in the specification sections where electrical work interfaces with other trades.

- F. Contract Documents are intended to show the scope and general arrangement of the Work under this Contract. 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.
- G. The contractor shall maintain as built drawings to reflect all changes made during construction and any deviations from the electrical drawings. This includes deviations from circuit numbers and any addition, deletion or relocation of fixtures/outlets shown on working drawings.

#### **1.04 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.

#### **1.05 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, Chapter 4. Division of Industrial Safety, Subchapter 5. Electrical Safety Orders (Cal/OSHA):
    - a. Low-Voltage Electrical Safety Orders (Sections 2299 - 2599)
    - b. High-Voltage Electrical Safety Orders (Sections 2700 - 2989)
  - 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. ANSI American National Standards Institute
  - 2. IEEE Institute of Electrical and Electronic Engineers
  - 3. NEMA National Electrical Manufacturer's Association
  - 4. NFPA National Fire Protection Association Standards
  - 5. UL Underwriters Laboratories

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- 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. Nothing in these drawings and specifications shall be construed to permit work not conforming to governing codes or regulations. 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.

#### **1.06 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 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.

#### **1.07 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, conduits, 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.

#### **1.08 DISCREPANCIES**

- A. The contractor shall check all drawings furnished to him immediately upon their receipt and shall promptly notify the owner of any discrepancies. Figures marked on drawings shall in general be followed in preference to scale measurements. Large scale drawings in general govern small scale drawings. The contractor shall compare all drawings and verify the figures before laying out the work and will be responsible for any errors which might have been avoided thereby. Where no figures or notations are given, the plans shall be followed

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- B. Omissions from the Drawings or Specifications or the erroneous description of details of work which are manifestly necessary to carry out the intent of the Drawings and Specifications, or which are customarily performed, shall not relieve the Contractor from performing such omitted or erroneously described details of the work but they shall be performed as if fully and correctly set forth and described in the drawings and specifications.
- 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.

#### **1.09 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.

#### **1.10 SUBMITTALS**

- A. Refer to Division 01 for additional requirements.
- B. 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.
- C. The manufacturer shall resubmit the specification section showing compliance with each respective paragraphs and specified items and features in that particular specification section.
- D. All exceptions shall be clearly identified by referencing respective paragraph and other requirements along with proposed alternative.
- E. Note that prior to acceptance of submittals for review, a submittal schedule shall be submitted to the Owner's Representative.
- F. Submit all Division 26 shop drawings and product data grouped and referenced by the specification technical section number in one complete submittal package.
- G. 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

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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 UL, 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.

- H. The Contractor shall submit all passcodes and passwords for any hardware and software required for the operations and troubleshooting in all systems and components no less than fourteen (14) calendar days prior to Final Completion.

## **1.11 PROJECT RECORD DOCUMENTS**

- A. Refer to Division 01 for additional requirements.
  1. All changes, deviations and information recorded on the "Project Record Drawings" set during Construction shall be redrafted using the latest version of AutoCAD or Revit, where applicable.
  2. Submit completed shop drawings to the Owner prior to completion in digital format.
  3. Contractor hand-marked or drafted redlined "Project Record Drawings" will not be accepted.

## **1.12 PRODUCT ALTERNATIVES OR SUBSTITUTIONS**

- A. Refer to General Conditions and Division 01 for additional requirements.



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### **1.13 OPERATING INSTRUCTIONS**

- A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel.

### **1.14 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.

### **1.15 DELIVERY AND STORAGE**

- A. Refer to Division 01 for additional requirements.
- B. 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.

### **1.16 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.

## **PART 2 - PRODUCTS**

### **2.01 COMPETITIVE PRODUCTS**

- A. Unless otherwise noted, any reference in the Specification to any article, device, product, material, fixture, form, or type of construction by name, make, or catalog number shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. The Contractor may at his option propose substitutions for such material in accordance with the substitution procedure outlined in the Contract Documents.
- B. Equipment specified in the following SECTIONS shall all be provided by the same manufacturer.
  - 1. 262416 Panelboards



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## 2.02 MATERIALS

- A. Provide all new materials and equipment, free from any defects, in first-class condition, and suitable for the space provided. Provide materials and equipment approved by UL authority having jurisdiction approved testing agency, wherever standards have been established by that agency.
- B. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of units or equipment need not be products of the same manufacturer.
- C. Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturers' latest standard design that conforms to these Specifications.
- D. Provide materials and equipment with manufacturers' standard finish system, except where otherwise specified. Provide manufacturers' standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with ANSI Number 61, light gray color.
- E. Environmental and Seismic Conditions: Material and Equipment shall be designed to insure satisfactory operation and operational life in the environmental and seismic conditions which will prevail where they are being installed. Electrical equipment and enclosures shall be designed, constructed and certified to withstand external loading conditions as prescribed by the California Building Code for the locations of the equipment. Supplied equipment shall either be shake table tested and certified or comprehensive seismic calculations shall be provided. All seismic calculations and structural drawings shall bear the seal of a Structural Professional Engineer currently licensed in the State of California. Earthquake design shall be based on the equivalent lateral force analysis procedure (ASCE 7-05 Section 12.8) with the following factors:

1. Location: 33.74765 LAT, -118.19099 LONG  
Site Class E  
 $S_s = 1.592$  g,  $S_1 = 0.600$  g,  
 $S_{MS} = 1.433$  g,  $S_{M1} = 1.440$  g,  
 $S_{DS} = 0.955$  g,  $S_{D1} = 0.960$  g
2.  $R = 2$  (Enclosure Attachment)  
 $R = 1.5$  (Transformer Attachment)
3.  $CS = 0.51$
4.  $SDC = D$
5.  $V = 52$  k (Enclosure and Electrical Equipment)

## PART 3 - EXECUTION

### 3.01 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.

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### **3.02 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 construction or rearrangement of furnishings or equipment, such changes shall be made without extra cost, providing the change is ordered before the conduit runs, 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. The electrical drawings do not indicate all fittings, hardware, or appurtenances required for a complete operating installation.
- I. Wiring diagrams are not intended to indicate the exact course of raceways.
- J. One-line and riser diagrams are only schematics and do not show physical arrangements of equipment.
- K. All workmanship, including aesthetic as well as electrical aspects of the Work, shall be of the highest quality consistent with the best practices of the trade.
- L. Replace or repair, without additional compensation, any Work, which, in the opinion of the Owner, does not comply with these requirements.

### **3.03 CLEANING & PAINTING OF EQUIPMENT**

- A. Refer to Division 09 for additional requirements.
- B. Factory Applied:

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1. Electrical 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: Paint electrical equipment as required to touch up, to match finish on other equipment in adjacent spaces, or to meet safety criteria.
- D. After installation, all metal finishes shall be polished and cleaned of all dirt, rust, cement, plaster, grease, and paint.

**END OF SECTION**

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## **SECTION 26 05 19 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 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 260533 "Raceways and Boxes for Electrical Systems"
  - 2. Section 271000 "Communications Horizontal Cabling" for cabling used for voice and data circuits.
  - 3. Section 260553 "Identification for Electrical Systems."

#### **1.03 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. VFD: Variable frequency drive.

#### **1.04 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.
- C. Product Cable Schedule: Indicate type, use, location, and termination locations.

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#### **1.05 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.

#### **1.06 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-95-658/ NEMA WC 70.
  - 2. UL 1072.
  - 3. IEEE.
  - 4. ASTM.
  - 5. 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 with in 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 manufacturer 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. If alternate manufacturer of products other than what are specified in this section are submitted, all necessary documents not limited to cut sheets, technical information, test reports from recognized testing labs and factory test reports shall be submitted to the satisfaction of the owner/engineer to ensure quality and conformance to the specifications. Additional testing shall be undertaken if it is concluded by the owner/engineer that the submitted test reports are either insufficient or do not include all tests necessary for product acceptance. The tests shall be conducted by a recognized lab acceptable to the owner/engineer and all tests shall be witnessed by owner's/engineer's personnel. All testing procedures and test results shall be satisfactory to the owner/engineer. Contractor shall be responsible for arranging the tests, for transportation, food and lodging for minimum of one owner's/engineer's representative to witness the test at the testing lab. Include all costs for the above in the bid.
- I. Testing: Provide the services of an independent qualified testing laboratory to perform the specified field tests. Notify the University's Representative fourteen (14) days in advance of performance of work requiring testing.

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- 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 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 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

### 2.01 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
- B. Basis-of-Design Product:
  - 1. General Cable Technologies Corporation.
  - 2. Southwire Incorporated
  - 3. Alpha Wire.
  - 4. Belden Inc.
  - 5. Encore Wire Corporation.
- C. Conductor Material: Electrical grade, soft drawn annealed copper, 98 percent conductivity, and fabricated in accordance with ASTM and ICEA standards. Minimum size is number 12 for branch circuits, number 14 stranded for control wiring. Aluminum conductors are not permitted. 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 for all underground and wet locations.
- E. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for with ground wire.
- F. VFD 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, dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires, and sunlight- and oil-resistant outer PVC jacket.
  - 3. Comply with UL requirements for cables in Classes I and II, Division 2 hazardous location applications.

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- G. Provide separate neutral with each branch circuit serving outlets. When dedicated neutrals are provided, use color spiral to match associated phase.

## **2.02 CONNECTORS AND SPLICES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
  - 1. Ideal Industries, Inc.
  - 2. IlSCO
  - 3. NSI Industries LLC.
  - 4. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 5. 3M; Electrical Markets Division.
  - 6. TE Connectivity - Raychem.
  - 7. 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.

## **2.03 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**

### **3.01 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 VFD cable, which shall be extra flexible stranded.

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### **3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS**

- A. Service Entrance: 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 XHHW-2, single conductors in raceway
- E. Feeders Installed below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway.
- G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway
- H. Branch Circuits Installed Below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway
- I. Branch Circuits in Cable Tray: TC rated Type THHN-2-THWN-2, single conductors in raceway
- J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- K. VFD Output Circuits: Type XHHW-2 in metal conduit or Type TC-ER cable with braided shield with dual tape shield.

### **3.03 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 260533 "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.

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- 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 260529 "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.

### **3.04 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.

### **3.05 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.

### **3.06 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 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### **3.07 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 078413 "Penetration Firestopping."

### **3.08 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage an independent qualified testing agency to perform tests and inspections.

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- 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; mechanical equipment.
  - 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

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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## **SECTION 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 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.

#### **1.03 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.

#### **1.04 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.

#### **1.05 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. Grounding conductors, connectors.
- 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:

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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.

#### **1.06 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.

#### **1.07 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**

#### **2.01 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.

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- 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

## 2.02 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.

## 2.03 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.

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- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

## **2.04 GROUNDING ELECTRODES**

- A. Ground Rods: Copper-clad 3/4 inch by 10 feet (19 mm by 3 m) in diameter.

## **PART 3 - EXECUTION**

### **3.01 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. 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.
- D. 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.

### **3.02 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, non-shrink grout.

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### 3.03 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. 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.
- 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 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 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.
- F. 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.
- G. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode next to the pole and a separate insulated equipment grounding conductor in addition to grounding conductor

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installed with branch-circuit conductors. Provide a handhole for the grounding electrode at each pole.

### **3.04 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 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.
- C. 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.
- D. 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.



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- E. 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.
- F. 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.
- G. 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. 4AWG.
  - 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.

### 3.05 LABELING

- A. Comply with requirements in Section 260553 "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."

### 3.06 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, and at individual ground rods. Make tests at ground rods before any conductors are connected.

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- 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 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

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## **SECTION 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 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 260548 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

#### **1.03 DEFINITIONS**

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

#### **1.04 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 times the applied force.

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## **1.05 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.

## **1.06 INFORMATIONAL SUBMITTALS**

- A. Welding certificates.

## **1.07 QUALITY ASSURANCE**

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

## **1.08 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 077200 "Roof Accessories."

## **PART 2 - PRODUCTS**

### **2.01 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. Cooper B-Line, Inc.; a division of Eaton Inc.

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- b. ERICO International Corporation.
    - c. GS Metals Corp.
    - d. Thomas & Betts Corporation: A Member of the ABB Group.
    - e. Unistrut; Part of Atkore International,
  - 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.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron 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. 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, zinc-coated 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.

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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.

## **2.02 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 055000 "Metal Fabrications" for steel shapes and plates.

## **PART 3 - EXECUTION**

### **3.01 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 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 in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted 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 single-bolt conduit clamps using spring friction action for retention in support channel.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

### **3.02 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, 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.

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Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

- 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 thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
  6. To Steel: 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.

### **3.03 INSTALLATION OF FABRICATED METAL SUPPORTS**

- A. Comply with installation requirements in Section 055000 "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.

### **3.04 CONCRETE BASES**

- A. Construct concrete bases of dimensions indicated but not less than 4 inches 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, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "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.

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**3.05 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.
- B. Touchup: Comply with requirements in Section 099113 "Exterior Painting" 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



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## **SECTION 26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 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 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

#### **1.03 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

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**1.04 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 manufacturers of the same material are not acceptable.
- C. Comply with California Electric Code (CEC)

**1.05 ACTION SUBMITTALS**

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

**1.06 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**

**2.01 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.

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2. Electri-Flex Company.
  3. O-Z/Gedney; a brand of EGS Electrical Group.
  4. Thomas & Betts Corporation.
  5. Western Tube and Conduit Corporation.
  6. 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.

## **2.02 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. RACO; a Hubbell company.
  5. Thomas & Betts Corporation.

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- 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."

## **2.03 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 unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

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## **2.04 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. Hoffman; a Pentair company.
  - 3. Hubbell Incorporated; Killark Division.
  - 4. RACO; a Hubbell Company.
  - 5. Thomas & Betts Corporation.
  - 6. 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: sheet metal.
  - 2. Type: Fully 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.
- G. 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.
- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- K. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
- L. Gangable boxes are prohibited.
- M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or 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.

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## **2.05 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.
  - 4. 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 Molded Products; a division of Oldcastle Precast, Inc.
  - 2. Standard: Comply with SCTE 77.
  - 3. Configuration: Designed for flush burial with open 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.

## **2.06 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.

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## PART 3 - EXECUTION

### 3.01 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Exposed Conduit: GRC
  - 2. Concealed Conduit, Aboveground: 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 in kitchens and damp or wet locations.
  - 9. Raceways serving light fixtures shall be minimum  $\frac{3}{4}$ " 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 fitting at the end of the equipment.
- 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.

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- 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).

### 3.02 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.



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- 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:

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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 semi recessed 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.

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- FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

### **3.03 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 312200 "Grading" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312200 "Grading".
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 312200 "Grading".
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 260553 "Identification for Electrical Systems."

### **3.04 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.

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- 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.

### **3.05 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 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### **3.06 FIRESTOPPING**

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

### **3.07 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

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## **SECTION 26 05 36 CABLE TRAYS FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 SUMMARY**

- A. Section Includes:
  - 1. Ladder cable trays.
  - 2. Single-rail cable trays.
  - 3. Trough cable trays.
  - 4. Fiberglass cable trays.

#### **1.03 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.

#### **1.04 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.

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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**

### **2.01 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.

### **2.02 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:

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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.

### 2.03 LADDER CABLE TRAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers

1. Chalfant Manufacturing Company.
2. Cooper B-Line, Inc.
3. Mono-Systems, Inc.

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: 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.

### 2.04 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.

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- 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.

## **2.05 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.

## **2.06 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 260553 "Identification for Electrical Systems."

## **2.07 SOURCE QUALITY CONTROL**

- A. Testing: Test and inspect cable trays according to NEMA VE 1.



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## **PART 3 - EXECUTION**

### **3.01 CABLE TRAY INSTALLATION**

- A. Install cable trays according to 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 260529 "Hangers and Supports for Electrical Systems." Comply with seismic-restraint details according to Section 260548 "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 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 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.

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- Q. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "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.

### **3.02 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."

### **3.03 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

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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.

### **3.04 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.

### **3.05 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 retorquing 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.

### **3.06 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

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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

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## **SECTION 26 05 43 UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 SUMMARY**

- A. This Section includes the following:
  - 1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct bank(s)
  - 2. Handholes and boxes.
- B. Related Requirements:
  - 1. Section 260526 "Grounding and Bonding of Electrical Systems".

#### **1.03 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

#### **1.04 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.

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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.

#### **1.05 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.

#### **1.06 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).

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#### **1.07 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 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.

#### **1.08 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.

#### **1.09 COORDINATION**

- A. Coordinate layout and installation of ducts, 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).

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## **PART 2 - PRODUCTS**

### **2.01 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 and Type EPC-80-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.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cantex, Inc.
  - 2. Thomas & Betts-Carlton
  - 3. Lamson & Sessions -Carlton Division
  - 4. JM Eagle
  - 5. Allied Tube and Conduit

### **2.02 NONMETALLIC DUCTS AND DUCT ACCESSORIES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 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.

### **2.03 PRECAST CONCRETE HANDHOLES AND BOXES**

- 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:



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1. Christy Concrete Products
  2. Oldcastle Precast Group
  3. Jensen Precast
- C. Comply with ASTM C 858 for design and manufacturing processes.
- D. 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" or "GROUNDING".
  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.

## **2.04 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE**

- A. Description: Comply with SCTE 77.
1. Color: Gray.

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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".
  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.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armorcast Products Company.
    - b. Carson Industries LLC.
    - c. CDR Systems Corporation.
    - d. NewBasis.
    - e. Oldcastle
- C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armorcast Products Company.
    - b. Carson Industries LLC.
    - c. Christy Concrete Products.
    - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.
    - e. Newbasis
- D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of fiberglass.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carson Industries LLC.
    - b. Christy Concrete Products.
    - c. Nordic Fiberglass, Inc.
- E. High-Density Plastic Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be polymer concrete.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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- a. Carson Industries LLC.
- b. Nordic Fiberglass, Inc.
- c. PenCell Plastics.

## **2.05 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. Jensen Precast
  - 4. Neenah Foundry Company.
  - 5. Oldcastle Precast Group.
  - 6. Underground Devices, Inc.
  - 7. Utility Concrete Products, LLC.
- B. 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.
- C. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (32-mm-) diameter eye, rated 2500-lbf (11-kN) minimum tension.
- D. 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.
- E. 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.
- F. 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.
- G. 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.

## **2.06 SOURCE QUALITY CONTROL**

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.

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- 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**

### **3.01 UNDERGROUND DUCT APPLICATION**

- A. Ducts for Electrical Feeders 600 V and Less: 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 direct-buried duct bank, unless otherwise indicated.
- C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40 PVC, in direct-buried duct bank, unless otherwise indicated.
- D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: 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 installed in duct bank, unless otherwise indicated.
- F. Underground Ducts Crossing Paved Paths, Walks, and Driveways: RNC, NEMA Type EPC-40 PVC, encased in reinforced concrete.

### **3.02 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 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 structural load rating.
  - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

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### **3.03 EARTHWORK**

- A. Excavation and Backfill: Comply with Section 31 22 00 "Grading", 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 329200 "Turf and Grasses" and Section 32 93 00 "Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Section 01 73 29 "Cutting and Patching."

### **3.04 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 of 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 26 05 44 "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.

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- 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.





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### **3.05 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. Waterproofing:** Apply waterproofing to exterior surfaces of handholes after concrete has cured at least three days. 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.

**F. Dampproofing:** Apply dampproofing to exterior surfaces of 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.

**G. Hardware:** 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.

**H. 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.

**I. Warning Sign:** Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.



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### **3.06 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE**

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level bed of 12 inches thick crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
- D. Install handholes and boxes with bottom below the frost line, <Insert depth of frost line below grade at Project site> below grade.
- 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 the enclosure.
- F. Field-cut openings for ducts and 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.
- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface of box cover frame. Bottom of ring shall rest on compacted earth.
  - 1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 03 30 00 "Cast-in-Place Concrete," with a troweled finish.
  - 2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

### **3.07 GROUNDING**

- A. Ground underground ducts and utility structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

### **3.08 FIELD QUALITY CONTROL**

- A. During construction, partially completed duct lines shall be protected from the entrance of debris such as mud, sand and dirt by means of suitable conduit plugs. As each section of a duct line is completed from manhole to vault, a testing mandrel not less than 12 inches long with a diameter 1/4-inch less than the size of the duct, shall be drawn through each duct, after which a brush having the diameter of the duct, and have stiff bristles shall be drawn through until the conduit is clear of all particles of earth, sand, gravel and other foreign materials. Conduit plugs shall then be immediately installed. Underground conduits, which terminate inside the building below grade, or which slope so that water might flow into building, shall be sealed at termination after installation of wires.
- B. Perform the following tests and inspections and prepare test reports:

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1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
  2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
  3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Correct deficiencies and retest as specified above to demonstrate compliance.

### **3.09 CLEANING**

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

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## **SECTION 26 05 44 SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 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.

#### **1.03 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

### **PART 2 - PRODUCTS**

#### **2.01 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:

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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).

## **2.02 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.

## **2.03 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. Pre-sealed Systems.

## **2.04 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.

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## **2.05 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 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**

### **3.01 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.

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- 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.

### **3.02 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.

### **3.03 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

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## **SECTION 26 05 48 VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.01 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

#### **1.02 VIBRATION ISOLATION AND NOISE CONTROL REQUIREMENTS**

- A. Flexible Electrical Connections:
  - 1. At connections to motors or other vibrating equipment

#### **1.03 DEFINITIONS**

- A. The IBC: International Building Code.
- B. CC-ES: ICC-Evaluation Service.
- C. 2019 California Building Code (CBC).

#### **1.04 PERFORMANCE REQUIREMENTS**

- A. Seismic restraints are to be based upon the prevailing building code.

### **PART 2 - PRODUCTS**

#### **2.01 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**

#### **3.01 INSTALLATION OF VIBRATION ISOLATION DEVICES:**

- A. Install vibration isolators per manufacturer's directions.
- B. Flexible electrical connections.

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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



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## **SECTION 26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 SUMMARY**

- A. Section Includes:
  - 1. Color and legend requirements for raceways, conductors, and warning labels and signs.
  - 2. Labels.
  - 3. Bands and tubes.
  - 4. Tapes and stencils.
  - 5. Tags.
  - 6. Signs.
  - 7. Cable ties.
  - 8. Paint for identification.
  - 9. Fasteners for labels and signs.

#### **1.03 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 electrical identification products.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For arc-flash hazard study.

#### **1.04 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.

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- 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**

### **2.01 PERFORMANCE REQUIREMENTS**

- 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. Comply with NFPA 70E and Section 26 05 73 "Short Circuit, Coordination and Arc-Flash Study" requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

### **2.02 COLOR AND LEGEND REQUIREMENTS**

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service' feeder and branch-circuit conductors.
  - 1. Color shall be factory applied.
  - 2. Colors for 208/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
  - 3. Color for Neutral: White.
  - 4. Color for Equipment Grounds: Green.
  - 5. Colors for Isolated Grounds: Green with white stripe.
- C. Raceways and Cables Carrying Circuits at More Than 600 V:
  - 1. Black letters on an orange field.
  - 2. Legend: To include "DANGER - CONCEALED HIGH VOLTAGE WIRING."

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- D. Warning Label Colors:
  - 1. Identify system voltage with black letters on an orange background.
- E. Warning labels and signs 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."
- F. Equipment Identification Labels:
  - 1. Black letters on a white field for equipment connected to normal power and Red letters on a white field for equipment connected to emergency/standby power unless otherwise indicated

## 2.03 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. HellermannTyton.
    - c. Marking Services, Inc.
    - d. Panduit Corp.
    - e. Seton Identification Products.
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. HellermannTyton.
    - c. Marking Services, Inc.
    - d. Panduit Corp.
    - e. Seton Identification Products.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyesterflexible label with acrylic pressure-sensitive adhesive.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Grafoplast Wire Markers.
    - c. Ideal Industries, Inc.
    - d. Marking Services, Inc.

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- e. Panduit Corp.
    - f. Seton Identification Products.
  - 2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
  - 3. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
  - 4. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Grafoplast Wire Markers.
    - c. HellermannTyton.
    - d. Ideal Industries, Inc.
    - e. Marking Services, Inc.
    - f. Panduit Corp.
    - g. Seton Identification Products.
  - 2. Minimum Nominal Size:
    - a. 1-1/2 by 6 inches for raceway and conductors.
    - b. 3-1/2 by 5 inches for equipment.
    - c. As required by authorities having jurisdiction.

## 2.04 BANDS AND TUBES

- A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. HellermannTyton.
    - c. Marking Services, Inc.
    - d. Panduit Corp.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Panduit Corp.

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## 2.05 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carlton Industries, LP.
    - b. HellermannTyton.
    - c. Ideal Industries, Inc.
    - d. Marking Services, Inc.
    - e. Panduit Corp.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Carlton Industries, LP.
    - c. emedco.
    - d. Marking Services, Inc.
- C. Tape and Stencil: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background and is 12 inches wide. Stop stripes at legends.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. HellermannTyton.
    - b. LEM Products Inc.
    - c. Marking Services, Inc.
    - d. Seton Identification Products.
- D. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carlton Industries, LP.
    - b. Seton Identification Products.
- E. Underground-Line Warning Tape:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Ideal Industries, Inc.
    - c. Marking Services, Inc.
    - d. Seton Identification Products.

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2. Tape:
    - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
    - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
    - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
  3. Color and Printing:
    - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
    - b. Inscriptions for Red-Colored Tapes: "CAUTION BURIED ELECTRIC LINE, HIGH VOLTAGE".
    - c. Inscriptions for Orange-Colored Tapes: "CAUTION BURIED TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
  4. Tag: Type IID:
    - a. 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.
    - b. Width: 6 inches.
    - c. Overall Thickness: 5 mils.
    - d. Foil Core Thickness: 0.35 mil.
    - e. Weight: 34 lb./1000 sq. ft.
    - f. Tensile according to ASTM D 882: 300 lbf and 12,500 psi.
- F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be inch unless otherwise indicated. If requested by Architect, match Owner's existing legend type, size etc.

## 2.06 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Carlton Industries, LP.
    - c. emedco.
    - d. Marking Services, Inc.
    - e. Seton Identification Products.

## 2.07 SIGNS

- A. Baked-Enamel Signs:

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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carlton Industries, LP.
  - b. Champion America.
  - c. emedco.
  - d. Marking Services, Inc.
2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
3. 1/4-inch grommets in corners for mounting.
4. Nominal Size: 7 by 10 inches.

**B. Laminated Acrylic or Melamine Plastic Signs:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Carlton Industries, LP.
  - c. emedco.
  - d. Marking Services, Inc.
2. Engraved legend.
3. Thickness:
  - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
  - b. For signs larger than 20 sq. in., 1/8 inch thick.
  - c. Engraved legend with black letters on white face background for equipment connected to normal power and red letters on white face background for equipment connected to emergency/standby power. Verify with Architect if legend has to match Owner's existing signs.
  - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
  - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## **2.08 CABLE TIES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. HellermannTyton.
  2. Ideal Industries, Inc.
  3. Marking Services, Inc.
  4. Panduit Corp.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
  1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black.

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- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
  - 1. Minimum Width: 3/16 inch.
  - 2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
  - 3. UL 94 Flame Rating: 94V-0.
  - 4. Temperature Range: Minus 50 to plus 284 deg F.
  - 5. Color: Black.

## **2.09 MISCELLANEOUS IDENTIFICATION PRODUCTS**

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain 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**

### **3.01 PREPARATION**

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

### **3.02 INSTALLATION**

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.



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- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer. Refer to drawings for additional information.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
- M. Vinyl Wraparound Labels:
  - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
  - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- P. Self-Adhesive Labels:
  - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
  - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

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1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- W. Underground Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway 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.
  2. Limit use of underground-line warning tape to direct-buried cables.
  3. Install underground-line warning tape for direct-buried cables and cables in raceways.
- X. Metal Tags:
1. Place in a location with high visibility and accessibility.
  2. Secure using general-purpose UV-stabilized cable ties for all area except use plenum-rated cable ties in plenum areas.
- Y. Nonmetallic Preprinted Tags:
1. Place in a location with high visibility and accessibility.
  2. Secure using general-purpose UV-stabilized in all areas except use plenum-rated cable ties in plenum areas.
- Z. Baked-Enamel Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.
- AA. Laminated Acrylic or Melamine Plastic Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.
- BB. Cable Ties: General purpose, for attaching tags, except as listed below:
1. Outdoors: UV-stabilized nylon.
  2. In Spaces Handling Environmental Air: Plenum rated.

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### 3.03 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch-high, black letters on 20-inch centers.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, and at 10-foot maximum intervals unless otherwise indicated.
- D. 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 raceway labels.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- E. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
  - 3. "UPS."
- F. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive wraparound labels to identify the phase.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- G. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.
- H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive 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 to conductors and list source.
- K. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

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- L. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- M. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:
  - 1. Floor surface directly above conduits running beneath and within 12 inches 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.
- N. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- O. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- P. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Metal-backed, butyrate warning signs.
  - 1. Apply to exterior of door, cover, or other access.
  - 2. 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.
- Q. Arc Flash Warning Labeling: Self-adhesive labels.
- R. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.
- S. Emergency Operating Instruction Signs: Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.
- T. Equipment Identification Labels:
  - 1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
  - 2. Outdoor Equipment: Laminated acrylic or melamine sign. Stenciled legend 4 inches high shall also be provided when requested by Architect.
  - 3. Equipment to Be Labeled:
    - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a engraved, laminated acrylic or melamine label.
    - b. Enclosures and electrical cabinets.
    - c. Access doors and panels for concealed electrical items.
    - d. Switchgear.
    - e. Switchboards.
    - f. Emergency system boxes and enclosures.
    - g. Enclosed switches.
    - h. Enclosed circuit breakers.

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- i. Remote-controlled switches, dimmer modules, and control devices.
- j. Battery-inverter units.
- k. Monitoring and control equipment.

END OF SECTION

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## **SECTION 26 05 72 OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY**

### **PART 1 - GENERAL**

#### **1.01 SUMMARY**

- A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of Low Voltage (LV) circuit protective devices.

#### **1.02 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.

#### **1.03 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 College 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.

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#### **1.04 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.

#### **1.05 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**

#### **2.01 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.

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## **2.02 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. 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. 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.



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- 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

#### 3.01 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.

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7. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
8. Motor horsepower and NEMA MG 1 code letter designation.
9. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

### **3.02 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. Medium and Low-voltage switchgear.
  4. Motor controllers.
  5. Variable Frequency Drives.
  6. Control panels.
  7. Branch circuit panelboards.
  8. Disconnect switches and Circuit Breakers.

### **3.03 ADJUSTING**

- A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

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**3.04 DEMONSTRATION**

- A. Train University's operating and maintenance personnel in the use of study results.

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## **SECTION 26 05 73 SHORT CIRCUIT, COORDINATION AND ARC FLASH STUDIES**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 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.

#### **1.03 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. Existing to remain items shall remain functional throughout the construction period.
- B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- C. One-Line Diagram: A diagram that 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.
- D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- E. Power System Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- G. SCCR: Short-circuit current rating.
- H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- I. Single-Line Diagram: See "One-Line Diagram."

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#### **1.04 ACTION SUBMITTALS**

##### **A. COORDINATION STUDIES**

1. Product Data: For computer software program to be used for studies.
2. 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.
3. Coordination-study input data, including completed computer program input data sheets.
4. Study and Equipment Evaluation Reports.
5. Coordination-Study Report.

##### **B. SHORT CIRCUIT STUDIES**

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.
  - a. Short-circuit study input data, including completed computer program input data sheets.
  - b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
  - c. Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

##### **C. ARC FLASH STUDIES**

1. Product Data: For computer software program to be used for studies.
2. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form:
3. Arc-flash study input data, including completed computer program input data sheets.
4. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.

#### **1.05 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For power systems analysis specialist.
- B. Product Certificates: For coordination-study, fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.
- D. Power Systems Analysis Software Developer
- E. Qualification Data: For Field Adjusting Agency

#### **1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For overcurrent protective devices to include in emergency, operation, and maintenance manuals.

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1. The following are from the Coordination Study Report:
  - a. Final one-line diagram.
  - b. Final protective device coordination study.
  - c. Coordination study data files.
  - d. List of all protective device settings.
  - e. Time-current coordination curves.
  - f. Power system data.
2. The following are from the Short-Circuit Study Report:
  - a. Final one-line diagram.
  - b. Final Short-Circuit Study Report.
  - c. Short-circuit study data files.
  - d. Power system data
3. The following are from the Arc Flash Hazard Report:
  - a. Provide maintenance procedures in equipment manuals according to requirements in NFPA 70E.
  - b. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

#### **1.07 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. Power Systems Analysis 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.
- E. Field Adjusting Agency Qualifications:
  1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
  2. A member company of NETA.
  3. Acceptable to authorities having jurisdiction

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## **PART 2 - PRODUCTS**

### **2.01 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 the product indicated on Drawings or a comparable product by one of the following:
  - 1. Operation Technology, Inc. (ETAP)
  - 2. SKM Systems Analysis, Inc.(Power Tools)

### **2.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS**

- A. Comply with IEEE 399, IEEE 1584 and NFPA 70E.
- B. Analytical features of fault-current-study, device coordination study and arc flash 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**

### **3.01 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.

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### 3.02 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.

### 3.03 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:



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1. Switchgear and switchboard bus.
  2. Distribution panelboard.
  3. 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 according to IEEE 551.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with 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-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.

### 3.04 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.

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3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with 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.

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### **3.05 ARC-FLASH HAZARD ANALYSIS**

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination study prior to starting the Arc-Flash Hazard Analysis.
  - 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
  - 2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."
- C. Calculate maximum and minimum contributions of fault-current size.
  - 1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
  - 2. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
  - 3. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
  - 4. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.
- D. Calculate the arc-flash protection boundary and incident energy at locations in 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. Calculate the limited, restricted, and prohibited approach boundaries for each location.
- 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 shall not be considered beyond three to five cycles.
  - 2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
- H. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for 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.

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### **3.06 ARC-FLASH STUDY REPORT CONTENT**

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram, showing the following:
  - 1. Protective device designations and ampere ratings.
  - 2. Conductor types, sizes, and lengths.
  - 3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
  - 4. Motor and generator designations and kVA ratings.
  - 5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 73.13 "Short-Circuit Studies."
- F. Arc-Flash Study Output Reports:
  - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:
    - 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.
- G. 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. Restricted approach boundary.
  - 6. Limited approach boundary.
  - 7. Working distance.
  - 8. Incident energy.
  - 9. Hazard risk category.
  - 10. Recommendations for arc-flash energy reduction.
- H. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

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### **3.07 ARC-FLASH WARNING LABELS**

- A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch (76-by-127-mm) self-adhesive equipment label for each work location included in the analysis.
- B. 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. Protection boundaries.
    - a. Arc-flash boundary.
    - b. Restricted approach boundary.
    - c. Limited approach boundary.
  - 4. Arc flash PPE category.
  - 5. Required minimum arc rating of PPE in Cal/cm squared.
  - 6. Available incident energy.
  - 7. Working distance.
  - 8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.
- D. Apply a label to each piece of equipment addresses by the study.

END OF SECTION

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## **SECTION 26 09 13 ELECTRICAL POWER MONITORING AND CONTROL**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 SUMMARY**

- A. Section includes the following for monitoring and control of electrical power system:
  - 1. PC-based workstation(s) and software.
  - 2. Communication network and interface modules for RS-232 RS-485, Modbus TCP/IP data transmission protocols.
- B. Related Sections:
  - 1. Section 262713 "Electricity Metering" for equipment to meter electricity consumption and demand for tenant submetering.

#### **1.03 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. Modbus TCP/IP: An open protocol for exchange of process data.

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- 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-232: A TIA standard for asynchronous serial data communications between terminal devices.
- N. RS-485: A TIA standard for multipoint communications using two twisted-pairs.
- O. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- P. THD: Total harmonic distortion.
- Q. UPS: Uninterruptible power supply; used both in singular and plural context.
- R. WAN: Wide area network.

#### **1.04 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
  - 1. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.
- 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.
- C. Sustainable Design Submittals:
  - 1. Product Data: Indicating that computers used by the system are certified by ENERGY STAR.

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#### **1.05 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified Installer manufacturer.
- B. Field quality-control reports.
- C. Other Informational Submittals:
  - 1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

#### **1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For power monitoring and control units, 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. 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, emergency boot diskettes, 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 on CD-ROM of the hard-copy submittal.

#### **1.07 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. Addressable Relays: One for every 10 installed. Furnish at least one of each type.
  - 2. Data Line Surge Suppressors: One for every 10 of each type installed. Furnish at least one of each type.
  - 3. I/O Protection Fuses: One for every 10 of each type installed. Furnish at least one of each type.

#### **1.08 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.



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## **1.09 COORDINATION**

- A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.
  - 1. Match components and interconnections for optimum performance of specified functions.
- B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

## **1.10 SOFTWARE SERVICE AGREEMENT**

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software.
  - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

## **PART 2 - PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide Veris E51H5 power meter.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by Veris.

### **2.02 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.
- B. 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.

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5. Voltage excursions.

C. System: Report equipment status.

## **2.03 SYSTEM REQUIREMENTS**

- A. Monitoring and Control System: Include with its operating system and application software, connected to the College'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.
- C. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.
- D. DDC Interface: Provide factory-installed hardware and software to enable the DDC to monitor, display, and record data for use in processing reports.
  - 1. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption (kilowatt-hours), power factor.
  - 2. ASHRAE 135 (BACnet) communication interface with the DDC shall enable the DDC operator to remotely monitor meter information from a DDC operator workstation. Control features and monitoring points displayed locally at metering panel shall be available through the DDC BAS.

## **2.04 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.

## **2.05 COMMUNICATION COMPONENTS AND NETWORKS**

- A. Network Configuration: High-speed, multi-access, open nonproprietary, industry standard communication protocol; LANs complying with EIA 485, 100 Base-T Ethernet, and Modbus TCP/IP.

## **2.06 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:

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1. Indoor installation in non-temperature-controlled spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) 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.

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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 63rd 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.

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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 63rd 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.

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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. Waveform Capture:
1. Capture and store steady-state waveforms of voltage and current channels; initiated manually. Each capture shall be for 3 cycles, 128 data points for each cycle, allowing resolution of harmonics to 31st harmonic of basic 60 Hz.
  2. Store captured waveforms in internal nonvolatile memory; available for PC display, archiving, and analysis.
- Q. 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.
- R. 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.
- S. Onboard Data Logging:

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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.

T. Alarms.

1. User Options:
  - a. Define pickup, dropout, and delay.
  - b. Assign one of four severity levels to make it easier for user to respond to the most important events first.
  - c. Allow for combining up to four alarms using Boolean-type logic statements for outputting a single alarm.
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.

U. Control Power: 90- to 457-V ac or 100- to 300-V dc.

V. Communications:

1. Power monitor shall be permanently connected to communicate via Modbus TCP via a 100 Base-T Ethernet or RS-485 Modbus TCP/IP.
2. Local plug-in connections shall be for RS-232 and 100 Base-T Ethernet.

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W. Display Monitor:

1. Backlit LCD to display metered data with touch-screen 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 four values on one screen at same time.
  - a. Current, per phase rms, three-phase average and neutral.
  - 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).

## 2.07 STANDALONE, WEB-ENABLED MONITORING AND CONTROL INSTRUMENT

- A. Separately mounted, permanently installed instrument for power monitoring and control.
  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 nontemperature-controlled spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) 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. LAN Connectivity: Multipoint, RS-485 Modbus 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 100 Base-T LAN.



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- 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.
  - 10. Export historical energy data to a PC or workstation through network using FTP (File Transfer Protocol). Format exported data in a CSV (Comma Separated Variable) file format for importing into spreadsheet applications.

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J. Communications:

1. Power monitor: Permanently connected to communicate via RS-485 Modbus TCP/IP or Modbus TCP via a 100 Base-T Ethernet.
2. Local Plug-in Connections: RS-232 and 100 Base-T Ethernet.
3. Monitor Display: Backlighted LCD to display metered data with touch-screen.

## 2.08 RS-232 ASCII INTERFACE

- A. ASCII interface shall allow RS-232 connections to be made between a meter or circuit monitor operating as the host PC and any equipment that will accept RS-232 ASCII command strings, such as local display panels dial-up modems and alarm transmitters.
- B. Pager System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.
1. RS-232 output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to paging system. This interface shall support both numeric and alphanumeric pagers.
- C. Alarm System Interface:
1. RS-232 output shall be capable of transmitting alarms from other monitoring and alarm systems to workstation software.
- D. Cables:
1. PVC-Jacketed, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
    - a. NFPA 70, Type CM.
    - b. Flame Resistance: UL 1581, Vertical Tray.
  2. Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
    - a. NFPA 70, Type CMP.
    - b. Flame Resistance: NFPA 262, Flame Test.

## 2.09 LAN CABLES

- A. Comply with Section 27 10 00 "Communication Cabling".
- B. RS-485 Cable:

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1. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.
  2. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket, and NFPA 70, Type CMP.
- C. Unshielded Twisted Pair Cables: Category 6 as specified for horizontal cable for data service in Section 27 10 00 "Communication Cabling".

## **2.10 LOW-VOLTAGE WIRING**

- A. Comply with Section 26 05 23 "Control-Voltage Electrical Power Cables."
- B. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.
  1. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
  2. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
  3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

## **PART 3 - EXECUTION**

### **3.01 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.

### **3.02 CABLING**

- A. Comply with NECA 1.
- B. Install cables and wiring according to requirements in Section 27 10 00 "Communication Cabling".
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Use NRTL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables 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.

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### **3.03 IDENTIFICATION**

- A. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."
- B. Label each power monitoring and control module with a unique designation.

### **3.04 GROUNDING**

- A. Comply with IEEE 1100, "Recommended Practice for Powering and Grounding Electronic Equipment."

### **3.05 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. Electrical Tests: Use caution when testing devices containing solid-state components.
  - 2. Continuity tests of circuits.
  - 3. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.
    - a. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
    - b. Test LANs according to requirements in Section 27 10 00 "Communication Cabling".
    - c. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of calculated battery operating time.
    - d. Verify accuracy of graphic screens and icons.
    - e. Metering Test: Load feeders, measure loads on feeder conductor with a rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.
    - f. Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.

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- E. Power monitoring and control equipment will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Correct deficiencies make necessary adjustments, and retest. Verify that specified requirements are met.
- H. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
- I. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.
- J. Remove and replace malfunctioning devices and circuits and retest as specified above.

### **3.06 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems. See Section 01 79 00 "Demonstration and Training."

### **3.07 ON-SITE ASSISTANCE**

- A. 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.

END OF SECTION

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## **SECTION 26 09 43 NETWORK LIGHTING CONTROLS**

### **PART 1 - GENERAL**

#### **1.01 SUMMARY**

- A. Section includes a networked lighting control system comprised of the following components
  - 1. System Software Interfaces
  - 2. System Backbone and Integration Equipment
  - 3. Wired Networked Devices
  - 4. Wireless Mesh Networked Devices
  - 5. Wireless Dual-Band Networked Devices
  - 6. The networked lighting control system shall meet all of the characteristics and performance requirements specified herein.
  - 7. The contractor shall provide, install and verify proper operation of all equipment necessary for proper operation of the system as specified herein and as shown on applicable drawings.

#### **1.02 RELATED DOCUMENTS**

- A. Section 26 27 26 Wiring Devices
- B. Section 26 51 00 LED Interior Lighting

#### **1.03 SUBMITTALS**

- A. Submittal shall be provided including the following items.
  - 1. Bill of Materials necessary to install the networked lighting control system.
  - 2. Product Specification Sheets indicating general device descriptions, dimensions, electrical specifications, wiring details, and nomenclature.
  - 3. Riser Diagrams showing device wiring connections of system backbone and floor plans pertinent to the specific project. Engineers design drawings returned back to the Engineer for review are not acceptable.

#### **1.04 APPROVALS**

- A. Prior approval from owner's representative is required for products or systems manufactured by companies not specified in the Network Lighting Controls section of this specification.
- B. Any alternate product or system that has not received prior approval from the owner's representative at least 10 days prior to submission of a proposal package shall be rejected.

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- C. Alternate products or systems require submission of catalog datasheets, system overview documents and installation manuals to owner's representative. The submittal shall include significant differences between the specified product and the alternate.

## **1.05 QUALITY ASSURANCE**

### **A. Product Qualifications**

- 1. System electrical components shall be listed or recognized by a nationally recognized testing laboratory (e.g., UL, ETL, or CSA) and shall be labeled with required markings as applicable.
- 2. System luminaires and controls shall be designed and manufactured for interoperability.
- 3. All components shall be subjected to 100% end of line testing prior to shipment to the project site to ensure proper device operation.
- 4. All components and the manufacturing facility where product was manufactured must be RoHS compliant.

### **B. Installation and Startup Qualifications**

- 1. System start-up shall be performed by qualified personnel approved or certified by the manufacturer.

### **C. Service and Support Requirements**

- 1. Phone Support: Toll free technical support shall be available.
- 2. Remote Support: The bidder shall offer a remote support capability.
- 3. Onsite Support: The bidder shall offer onsite support that is billable at whole day rates.
- 4. Service Contract: The bidder shall offer a Service Contract that packages phone, remote, and onsite support calls for the project. Response times for each type of support call shall be indicated in the terms of the service contract included in the bid package.

## **1.06 PROJECT CONDITIONS**

### **A. Only install equipment after the following site conditions are maintained:**

- 1. Ambient Temperature: 14 to 105°F.
- 2. Relative Humidity: less than 90% non-condensing

### **B. Equipment shall not be subjected to dust, debris, moisture, or temperature and humidity conditions exceeding the requirements indicated above, at any point prior to installation.**

### **C. Only properly rated equipment and enclosures, installed per the manufacturer's instructions, may be subjected to dust and moisture following installation.**

## **1.07 WARRANTY**

- A. The manufacturer shall provide a minimum five-year warranty on all hardware devices supplied and installed. Warranty coverage shall begin on the date of shipment.
- B. The hardware warranty shall cover repair or replacement, including programming, any defective products within the warranty period.

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## **1.08 MAINTENANCE & SUSTAINABILITY**

- A. The manufacturer shall make available to the owner new parts, upgrades, and/or replacements available for a minimum of 5 years following installation.

## **PART 2 - EQUIPMENT**

### **2.01 MANUFACTURERS**

- A. Acceptable Manufacturers:
  - 1. nLight, Acuity Brands Lighting, Inc.
- B. Basis of Design System: Acuity Controls nLight

### **2.02 SYSTEM COMPLIANCE**

- A. System components shall comply with UL 916 and UL 924 standards where applicable.
- B. System components shall comply with CFR Title 47, Part 15 standards where applicable.
- C. All equipment shall be installed and connected in compliance with NFPA 70.

### **2.03 SYSTEM PERFORMANCE REQUIREMENTS**

- A. System Architecture
  - 1. System shall have an architecture that is based upon three main concepts: (1) networkable intelligent lighting control devices, (2) standalone lighting control zones using distributed intelligence, (3) optional system backbone for remote, time based and global operation between control zones.
  - 2. Intelligent lighting control devices shall have individually addressable network communication capability and consist of one or more basic lighting control components: occupancy sensor, photocell sensor, relay, dimming output, contact closure input, analog 10V input, and manual wallstation capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure shall be permissible so as to minimize overall device count of system.
  - 3. System must be capable of interfacing directly with networked luminaires such that either low voltage network cabling or wireless RF communication is used to interconnect networked luminaires with control components such as sensors, switches and system backbone (see Control Zone Characteristics sections for each type of network connection, wired or wireless).
  - 4. Lighting control zones consisting of one or more networked luminaires and intelligent lighting control devices and shall be capable of providing automatic control from sensors (occupancy and/or photocell) and manual control from local wallstations without requiring connection to a higher-level system backbone; this capability is referred to as "distributed intelligence."
  - 5. The system shall be capable of providing individually addressable switching and dimming control of the following: networked luminaires, control zones, and relay and dimming



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outputs from centralized panels to provide design flexibility appropriate with sequence of operations required in each project area or typical space type.

6. Networked luminaires and intelligent lighting control devices shall support individual (unique) configuration of device settings and properties.
7. Networked luminaires and intelligent lighting control devices shall have distributed intelligence programming stored in non-volatile memory such that following any loss of power the lighting control zones shall operate according to their defined default settings and sequence of operations.
8. Lighting control zones shall be capable of being networked with a higher level system backbone to provide time based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through a software interface.
9. The system may include one or more system controllers that provide time-based control and global system control across multiple control zones and backbone network segments. The system controller also provides a means of connecting the lighting control system to a system software interface and building management systems via BACnet/IP protocol.
10. The system may include "communication bridge" devices that route communication from lighting control zones (wired or wireless) to and from the system controller, for purposes of decreasing system wiring requirements.
11. All system devices shall support remote firmware update, such that physical access to each device is not necessary, for purposes of upgrading functionality at a later date.

#### B. Wired Networked Control Zone Characteristics

1. Connections to devices within a wired networked lighting control zone and to backbone components shall be with a single type of low voltage network cable, which shall be compliant with CAT5e specifications or higher. To prevent wiring errors and provide cost savings, the use of mixed types of low voltage network cables shall not be permitted.
2. Devices in an area shall be connected via a "daisy-chain" topology; requiring all individual networked devices to be connected back to a central component in a "hub-and-spoke" topology shall not be permitted, so as to reduce the total amount of network cable required for each control zone.
3. System shall provide the option of having pre-terminated plenum rated low voltage network cabling supplied with hardware so as to reduce the opportunity for improper wiring and communication errors during system installation.
4. Following proper installation and provision of power, all networked devices connected together with low voltage network cable shall automatically form a functional lighting control zone without requiring any type of programming, regardless of the programming mechanism (e.g., software application, handheld remote, pushbutton). The "out of box" default sequence of operation is intended to provide typical sequence of operation so as to minimize the system start-up and programming requirements and to also have functional lighting control operation prior to system start-up and programming.
5. Once software is installed, system shall be able to automatically discover all connected devices without requiring any provisioning of system or zone addresses.
6. All networked devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/start-up personnel.
7. Networked control devices intended for control of egress and/or emergency light sources shall not require the use of additional, externally mounted UL924 shunting and/or 0-10V disconnect devices, so as to provide a compliant sequence of operation while reducing the overall installation and wiring costs of the system. The following types of wired networked control devices shall be provided for egress and/or emergency light fixtures:

#### C. Wireless Mesh Networked Control Zone Characteristics

1. No wired control connections between wireless networked devices shall be required.

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2. Wireless networked devices shall communicate via radio frequency of 2.4 GHz using a standards-based wireless mesh networking protocol.
3. Wireless network shall be self-healing, such that optimum routing paths between devices are automatically established or restored if any nodes are respectively added to or removed from the wireless network.
4. Wireless network communication shall support uniform and instant response such that all luminaires in a lighting control zone respond immediately and synchronously in response to a sensor or wallstation signal.
5. To support the system architecture requirement for distributed intelligence, wireless network communication shall support communication of control signals from sensors and wallstations to networked luminaires and wireless load control devices, without requiring any communication, interpretation, or translation of information through a backbone device such as a wireless access point, communication bridge or gateway.
6. All wireless communication shall be encrypted using the 128-bit Advanced Encryption Standard (AES).
7. Wet listed wireless networked luminaires and wireless sensing devices shall be offered, to support a wide variety of lighting control applications.
8. Networked control devices intended for control of egress and/or emergency light sources shall not require the use of additional, externally mounted UL924 shunting and/or 0-10V disconnect devices, so as to provide a compliant sequence of operation while reducing the overall installation and wiring costs of the system. The following types of wired networked control devices shall be provided for egress and/or emergency light fixtures:

D. Wireless Dual Band Networked Control Zone Characteristics

1. No wired connections between wireless networked devices shall be required.
2. Wireless networked devices shall communicate using two radio frequencies, 900 MHz and 2.4 GHz.
3. Multiple wireless networking protocols shall be supported:
4. Wireless network shall be self-healing, such that optimum communication between devices is automatically established or restored if any nodes are respectively added to or removed from the wireless network.
5. Wireless network communication shall support uniform and instant response such that all luminaires in a lighting control zone respond immediately and synchronously in response to a sensor or wallstation signal.
6. To support the system architecture requirement for distributed intelligence, wireless network communication shall support communication of control signals from sensors and wallstations to networked luminaires and wireless load control devices, without requiring any communication, interpretation, or translation of information through a backbone device such as a wireless access point, communication bridge or gateway.
7. All wireless communication shall support the following five tiers of security measures, so as to safely support Internet-connected applications.
8. Accounting for typical environmental conditions and building construction materials encountered within commercial indoor lighting environments, wireless mesh networked devices shall be capable of communicating to at least 300' spacing between luminaires with embedded wireless transceivers.
9. Wireless networked devices shall have a line-of-sight communication range of at least 1000 ft. under ideal environmental conditions.

E. System Integration Capabilities

1. The system shall interface with third party building management systems (BMS) to support two-way communication using the industry standard BACnet/IP or BACnet/MSTP

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protocols. The following system integration capabilities shall be available via BACnet/IP and BACnet/MSTP protocols:

F. Supported Sequence of Operations

1. The following characteristics and performance requirements shall apply to wired and wireless control zones provided by the system.
2. Control Zones
3. Wallstation Capabilities
4. Occupancy Sensing Capabilities
5. Photocell Sensing Capabilities (Automatic Daylight Sensing)
6. Schedule and Global Profile Capabilities
7. Automated demand response capabilities. Profiles created for automated demand response events shall support automatic reduction of light level to programmable values. At least four levels of demand response profiles shall be supported by the system.

## 2.04 SYSTEM SOFTWARE INTERFACES

A. Management Interface

1. System shall provide a web-based management interface that provides remote system control, live status monitoring, and configuration capabilities of lighting control settings and schedules.
2. Management interface must be compatible with industry-standard web browser clients, including, but not limited to, Microsoft Internet Explorer®, Apple Safari®, Google Chrome®, Mozilla Firefox®.
3. Management interface shall require all users to login with a User Name and Password and shall support creation of at least 100 unique user accounts.
4. Management interface shall support at least three permission levels for users: read-only, read & change settings, and full administrative system access.
5. Management interface shall be capable of restricting read-only and read & change access for user accounts to specific devices within the system.
6. All system devices shall be capable of being given user-defined names.
7. The following device identification information shall be displayed in the Management interface: model number, model description, serial number, manufacturing date code custom label(s), and parent network device.
8. Management interface shall be able to read the live status of a networked luminaire or intelligent control device and shall be capable of displaying luminaire on/off status, dim level, power measurement, device temperature, PIR occupancy sensor status, microphonic occupancy sensor status, remaining occupancy time delay, photocell reading, and active Scenes or Profiles.
9. Management interface shall be able to read the current active settings of a networked luminaire or intelligent control device and shall be capable of displaying dimming trim levels, occupancy sensor and photocell enable/disable, occupancy sensor time delay and light level settings, occupancy sensor response (normal or vacancy), and photocell setpoints and transition time delays.
10. Management interface shall be able to change the current active settings and also default settings for an individual networked luminaire or intelligent control device.

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11. Management interface shall be capable of applying settings changes for a zone of devices or a group of selected devices using a single "save" action that does not require the user to save settings changes for each individual device.
12. A printable network inventory report shall be available via the management interface.
13. A printable report detailing all system profiles shall be available via the management interface.
14. All sensitive information stored by the software shall be encrypted.
15. All system software updates must be available for automatic download and installation via the Internet.

B. Historical Database and Analytics Interface

1. System shall provide a historical database that stores device operational history and calculates energy usage for all networked luminaires and intelligent control devices.
2. System shall be capable of reporting lighting system events and performance data back to the historical database for display and analysis.
3. Historical database shall be capable of recording historical data for up to 20,000 networked devices for a period of at least 1 calendar year.
4. An "Energy Scorecard" shall be displayed that shows calculated energy savings in dollars, kWh, or CO2.
5. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc.).
6. Energy savings data shall be calculated for the system as a whole, or for individual zones.
7. A time scaled graph showing all relay transitions shall be presented.
8. A time scaled graph showing a zones occupancy time delay shall be presented
9. A time scaled graph showing the total light level shall be presented.
10. User shall be able to customize the baseline run-time hours for a space.
11. User shall be able to customize up to four time-of-day billing rates and schedules.
12. Historical data shall be exportable from the Historical Database via a "CSV" type of file format.

C. Visualization Interfaces

1. System shall provide a web-based visualization interface that displays graphical floorplan.
2. Graphical floorplan shall offer the following types of system visualization:

D. Personal Control Applications

1. Software interface shall support personal control software applications that provide user-specific control of individual luminaires, control zones, and scene presets.
2. Personal control applications shall support control of dimming output or definition of dimming presets for luminaires and devices that are dimmable.
3. The system administrator shall be capable of defining personal control permissions for each user account.
4. Software interface shall provide a Microsoft Windows® operating system taskbar application for personal lighting control.
5. Software interface shall provide an Apple iOS® operating system application (supported by mobile phones and mobile tablet devices) for personal lighting control.

E. Smartphone Programming Interface for Wired Devices

1. Application interface shall be provided for both Apple iOS® and Android operating systems that allows configuration of lighting control settings.
2. The application shall support the configuration of wired networked control devices via a Bluetooth® Low Energy (BLE) Programming Device.

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3. Programming capabilities through the application shall include, but not be limited to, the following:

## **2.05 SYSTEM BACKBONE AND SYSTEM INTEGRATION EQUIPMENT**

### **A. IP nLight ECLYPSE™ System Controller (IP-NE-CTRL)**

1. System Controller shall be multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
2. System Controller shall have 32-bit microprocessor operating at a minimum of 1 GHz.
3. System Controller shall have minimum of 512MB memory, with a minimum of 4GB non-volatile flash, to support its own operating system and databases.
4. System Controller shall perform the following functions:
5. System Controller shall have an integral web server to support configuration, diagnostics and hosting of software interfaces.
6. Device shall have option for a graphical touch screen to support configuration and diagnostics.
7. Device shall have three RJ-45 networked lighting control ports for connection to any of the following:
8. Device shall be capable of communicating with wireless mesh network bridges and software interfaces via LAN connection.
9. Device shall automatically detect all networked devices connected to it, including those connected to wired and wireless communication bridges.
10. Device shall have a standard internal time clock.
11. Device shall have 2 switched RJ-45 10/100 BaseT Ethernet ports for local area network (LAN) connection
12. Device shall have 2 x USB 2.0 Expansion ports for
13. Each System Controller shall be capable of managing and operating at least 1500 networked devices (wired or wireless).
14. System Controller shall support BACnet/IP and BACnet/MSTP protocols to directly interface with BMS and HVAC equipment without the need for additional protocol translation gateways.

### **B. OpenADR Interface**

1. System shall provide an interface to OpenADR protocol Demand Response Automation Servers (DRAS) typically provided by local electrical utility.
2. OpenADR interface shall meet all of the requirements of Open ADR 2.0a Virtual End Nodes (VEN), including:
3. OpenADR interface shall support the activation of system profiles configured for each of the automated demand response levels defined in the utility demand response program.

## **2.06 WIRED NETWORKED DEVICES**

### **A. Wired Networked Wall Switches, Dimmers, Scene Controllers**

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1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
3. All switches shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
4. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
5. Devices with mechanical push-buttons shall be made available with custom button labeling.
6. Wall switches & dimmers shall support the following device options:
7. Scene controllers shall support the following device options:

**B. Wired Networked Graphic Wallstations**

1. Device shall surface mount to single-gang switch box.
2. Device shall have a 3.5" full color touch screen.
3. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply.
4. Device shall have a micro-USB style connector for local computer connectivity.
5. Communication shall be over standard low voltage network cabling with RJ-45 connectors.
6. Device shall enable user supplied screen saver image to be uploaded within one of the following formats: jpg, png, gif, bmp, tif.
7. Device shall enable configuration of all switches, dimmers, and lighting preset scenes via password protected setup screens.
8. Graphic wallstations shall support the following device options:

**C. Wired Networked Auxiliary Input / Output (I/O) Devices**

1. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½ in knockout.
2. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
3. Auxiliary Input/Output Devices shall be specified as an input or output device with the following options:

**D. Wired Networked Occupancy and Photosensors**

1. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional "dual" technology shall be used.
4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR / Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR / Ultrasonic) shall not be acceptable.
5. All sensing technologies shall be acoustically passive, meaning they do not transmit sound waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.

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6. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
7. All sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
8. Sensor programming parameter shall be available and configurable remotely from the software and locally via the device push-button.
9. Network system shall have ceiling, fixture, recessed & corner mounted sensors available, with multiple lens options available customized for specific applications.
10. Sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).
11. Sensors shall be available with one or two occupancy "poles", each of which provides a programmable time delay.
12. Sensors shall have optional features for photosensor/daylight override, dimming control, and low temperature/high humidity operation.
13. Photosensor shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
14. Photosensor and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.
15. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
16. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The secondary daylight zone shall be capable of being controlled as an "offset" from the primary zone.

E. Wired Networked Wall Switch Sensors

1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
3. All wall switch sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
4. Devices with mechanical push-buttons shall provide tactile user feedback.
5. Wall switches sensors shall support the following device options:

F. Wired Networked Embedded Sensors

1. Network system shall have embedded sensors consisting of occupancy sensors and/or dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.
2. Occupancy sensor detection pattern shall be suitable for 7.5 ft. to 20 ft. mounting heights.
3. Embedded sensors shall support the following device options:

G. Wired Networked Power Packs and Secondary Packs

1. Power Packs shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage Class 2 power to the rest of the system.
2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC) and carry a plenum rating.
3. Secondary Packs shall incorporate the relay and 0-10 VDC or line voltage dimming output but shall not be required to contribute system power.

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4. Power Supplies shall provide system power only but are not required to switch line voltage circuit.
5. Auxiliary Relay Packs shall switch low voltage circuits only, capable of switching 1 amp at 40 VAC/VDC (resistive only).
6. Communication shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors. Secondary packs shall receive low voltage power via standard low voltage network cable.
7. Power Pack programming parameter shall be available and configurable remotely from the software and locally via the device push-button.
8. Power Pack shall securely mount to junction location through a threaded ½ in chase nipple or be capable of being secured within a luminaire ballast/driver channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
9. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
10. Power/Secondary Packs shall be available with the following options:
11. Power Pack capable of full 16-Amp switching of all normal power lighting load types, with optional 0-10V dimming output capable of up to 100mA of sink current.
12. Secondary Pack with UL924 listing for switching of full 16-Amp Emergency Power circuits, with optional 0-10V dimming output capable of up to 100mA of sink current.
13. Power and Secondary Packs capable of full 20-Amp switching of general-purpose receptacle (plug-load) control.
14. Secondary Pack capable of full 16-Amp switching of all normal power lighting load types.
15. Secondary Pack capable of 5-Amps switching and dimming 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
16. Secondary Pack capable of 5-Amps switching and dimming of 120/277 VAC magnetic low voltage transformers.
17. Secondary Pack capable of 4-Amps switching and dimming of 120 VAC electronic low voltage transformers.
18. Secondary Pack capable of louver/damper motor control for skylights.
19. Secondary Pack capable of providing a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
20. Secondary Pack capable of switching 1 amp at 40 VAC/VDC (resistive only) with the intent to provide relay signal to auxiliary system (e.g. BMS).
21. Power Supply capable of providing auxiliary bus power (no switched or dimmed load).

#### H. Wired Networked Relay and Dimming Panel

1. Relay and dimming panel shall be available with 4, 8, 12 or 16 individual Field Configurable Relays (FCR) per panel, with an equal number of individual 0-10V dimming outputs.
2. Standard relays used shall have the following required properties:
3. 0-10 dimming outputs shall support a minimum of 100mA sink current per output.
4. Relay and dimming outputs shall be individually programmable to support all standard sequence of operations as defined in this specification.
5. Panel shall be UL924 listed for control of emergency lighting circuits.
6. Panel shall power itself from an integrated 120-277VAC or 347VAC supply.
7. Panel shall provide a configurable low-voltage sensor input with the following properties:
8. Configurable to support any of the following input types:



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9. Panel shall provide a contact closure input that acts as a panel override to activate the normally configured state of all relays (i.e., normally open or normally closed) in the panel. This input is intended to provide an interface to alarm systems, fire panels, or BMS system to override the panel.
  10. Panel shall supply current limited low voltage power to other networked devices connected via low voltage network cable.
  11. Panel shall be available with NEMA 1 rated enclosure with the following properties:
  12. Panel shall be rated from 32-122 °F.
- I. Wired Networked Bluetooth® Low Energy Programming Device
1. Device shall be plenum rated and be inline wired, screw mountable.
  2. Communication and low voltage power shall be delivered to device via standard low voltage network cabling with RJ-45 connectors.
  3. Bluetooth Low Energy connection shall allow connection from smartphone application for programming device settings within the local daisy-chain zone (see list of available settings in section, 2.4-System Software Interfaces, Sub-section .5).
- J. Wired Networked Communication Bridge
1. Device shall surface mount to a standard 4" x 4" square junction box.
  2. Device shall have 8 RJ-45 ports for connection to lighting control zones (up to 128 devices per port), additional network bridges, and System Controller.
  3. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to System Controller.
  4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or powered via low voltage network connections from powered lighting control devices (e.g. power packs).
  5. Wired Bridge shall be capable of redistributing power from its local supply and connected lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

## **2.07 WIRELESS MESH NETWORKED DEVICES**

- A. Wireless Mesh Networked Sensor Interface
1. The wireless sensor interface shall integrate industry standard low voltage switching devices and contact closure outputs into the control network.
  2. The device interface shall have a universal power supply that operates at 120, 208, 240 or 277 VAC.
  3. The device shall be listed under the UL 916 standard to allow field installation.
  4. The device interface shall be suitable for mounting onto an electrical junction box and have UL 2043 listing for mounting in a plenum.
  5. The device interface shall provide 2 low voltage sensing input channels suitable for connecting to momentary contact wall switches and dry contact outputs from other systems.
  6. The device shall provide at least 100 mA of output power at 24VDC for connection to external input devices.
  7. The device shall be capable of broadcasting the following manual wall control commands: on, off, and adjust dim level.

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B. Wireless Mesh Networked Light Controllers

1. The wireless light controller shall have a line voltage relay and 0-10V dimming output suitable for control of commercial and industrial lighting including fluorescent, HID, induction and LEDs.
2. Device shall have a form factor similar to a slim European-style ballast, which is intended for installation directly inside the ballast channel of a fixture.
3. Device shall have an integrated internal antenna suitable for embedding inside of a commercial and industrial luminaire while maintaining reliable wireless communication for typical luminaire spacing in commercial and industrial applications (see Wireless Mesh Network Control Zone Characteristics). An external antenna attached to the luminaire shall not be allowed.
4. The wireless light controller shall have a universal power supply that operates at 120, 208, 240 or 277VAC.
5. The device shall be listed under the UL 916 standard to allow field installation.
6. Each wireless light controller shall provide measurement capability of the amperage, voltage, wattage, and watt-hours of its controlled lighting.
7. The wireless light controller shall have a connector for an optional digital occupancy sensor and photocell.
8. Wireless light controller shall have the following relay options:

C. Wireless Mesh Networked Digital Sensor Attachments

1. Digital sensor attachments provide integrated digital occupancy sensing and digital photocell sensor.
2. Devices shall connect directly to the wireless light controller and shall be suitable for embedding into the enclosure of a luminaire.
3. IP-rated digital sensor attachments shall be provided that maintain wet-location capability of a luminaire.
4. Device shall have software-adjustable sensitivity of PIR occupancy sensor.
5. Photocell shall be suitable for closed and open loop applications.
6. Device shall have a user button that may be used to provide diagnostic and factory-default reset capabilities.
7. Digital sensor attachment shall have the following form factors and lens types:

D. Wireless Mesh Networked Sensor-Controllers

1. Sensor-Controllers shall integrate the following functions in to a single enclosure:
2. Sensor-Controllers shall mount to luminaires or junction boxes with a secured chase nipple suitable for ½ in KO mounting holes.
3. Sensor-Controllers shall have optional IP-rated enclosures for wet location applications.
4. Sensor-Controllers shall be the following enclosures, relay options, and lens types:

E. Wireless Mesh Network Communication Bridge

1. A communication bridge device shall be provided that interfaces with the System Controller via LAN connection and interfaces with wireless mesh networked devices via an integrated 2.4 GHz transceiver.
2. Device shall provide an option to be powered from a Power-over-Ethernet connection conforming to the IEEE 802.3af standard.
3. Device shall provide an option to be powered from 120VAC electrical outlet.
4. Device shall consume no more than 6 W of power.

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5. Device shall be capable of communicating with a group of at least 250 wireless mesh networked devices and luminaires, so as to reduce the amount of communication bridges required in the system.
6. Device shall be supplied with mounting hardware suitable for wall mounting in an office environment or utility closet.
7. Device shall have optional IP-rated enclosure suitable for wet location applications.
8. Device shall have optional heated enclosure suitable for below-freezing applications.
9. To provide security, the wireless bridge shall be unresponsive to wired and wireless communication that do not conform to the specific protocols used by the networked lighting control system.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION REQUIREMENTS**

#### **A. Installation Procedures and Verification**

1. The successful bidder shall review all required installation and pre-startup procedures with the manufacturer's representative through pre-construction meetings.
2. The successful bidder shall install and connect the networked lighting control system components according to the manufacturer's installation instructions, wiring diagrams, the project submittals and plans specifications.
3. The successful bidder shall be responsible for testing of all lighting control low voltage network cable included in the bid. Bidder is responsible for verification of the following minimum parameters:

#### **B. Coordination with Owner's IT Network Infrastructure**

1. The successful bidder is required to coordinate with the owner's representative to secure all required network connections to the owner's IT network infrastructure.

#### **C. Documentation and Deliverables**

1. The installing contractor shall be responsible for documenting installed location of all networked devices, including networked luminaires. This includes responsibility to provide as-built plan drawing showing device address barcodes corresponding to locations of installed equipment.
2. The installing contractor is also responsible for the following additional documentation to the manufacturer's representative if visualization / graphical floorplan software is provided as part of bid package.

### **3.02 SYSTEM STARTUP**

#### **A. Upon completion of installation by the installer, including completion of all required verification and documentation required by the manufacturer, the system shall be started up and programmed by an authorized representative of the manufacturer.**

1. Low voltage network cable testing shall be performed prior to system startup.

#### **B. System start-up and programming shall include:**

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1. Verifying operational communication to all system devices.
  2. Programming the network devices into functional control zones to meet the required sequence of operation.
  3. Programming and verifying all sequence of operations.
  4. Customization of owner's software interfaces and applications.
- C. Initial start-up and programming is to occur on-site. Additional programming may occur on-site or remotely over the Internet as necessary.

### **3.03 PROJECT TURNOVER**

- A. System Documentation and as-builts.
1. Submit software database file with desired device labels and notes completed.
- B. Owner Training
1. Provisions for onsite training for owner and designated attendees to be included in submittal package. Training shall be a minimum of (1) day and shall be videotaped by the Contractor, and video provided to the Owner.
  2. Contractor shall include in their bid a second training to occur (6) months after occupancy of building by the Owner. The second training shall be a minimum of (4) hours.

END OF SECTION

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## **SECTION 26 24 16 PANELBOARDS**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 SUMMARY**

- A. Section Includes:
  - 1. Distribution panelboards.
  - 2. Lighting and appliance branch-circuit panelboards.
- B. Related Sections include the following:
  - 1. Section 26 05 53 "Identification for Electrical Systems".
  - 2. Section 26 05 73 "Overcurrent Protective Device Coordination Study" for short-circuit rating of devices and for setting of overcurrent protective devices.

#### **1.03 DEFINITIONS**

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RMS: Root mean square.
- D. SPDT: Single pole, double throw
- E. SPD: Surge Protective Device

#### **1.04 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Panelboards 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."
  - 2. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the latest California Building Code (CBC).
  - 3. Square D; a brand of Schneider Electric
  - 4. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 5. Siemens Energy & Automation, Inc..

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6. Coordinate two paragraphs below with Drawings. See the "Disconnecting and Overcurrent Protective Devices" Article in the Evaluations for guidance on making selections.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Where indicated provide circuit breakers UL listed for application at 100% of their continuous ampere rating in their intended enclosure.
  2. Thermal-Magnetic Circuit Breakers (below 400A frame): Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Provide field adjustable magnetic trip setting for circuit-breakers serving motor loads or other special applications as indicated
  3. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  4. Electronic trip circuit breakers (400A frame size and larger) with rms sensing; field-replaceable rating plug or field-replaceable 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.
    - e. CBs shall have an integral power supply installed at the factory if required for proper functioning of the breaker. An external power supply shall not be acceptable.
  5. Circuit breakers shall have a minimum interrupting rating of 10,000 amperes RMS symmetrical at 240 volts, and 14,000 amperes RMS symmetrical at 480 volts, unless otherwise noted on the drawings. Verify maximum available fault levels from the Short Circuit and Coordination Study. Minimum interrupting rating (AIC) shall be 110% of the available fault level.
  6. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
  7. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
  8. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
  9. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
  10. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
    - 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. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
    - e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
    - f. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
    - g. Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management, and control system (EMCS) panels and fire alarm panels.

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- C. 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: Standard ampere ratings and number of poles.
  - 3. Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.
- D. All panelboards shall have double hinged covers.

## **1.05 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 panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

## **PART 2 - EXECUTION**

### **2.01 EXAMINATION**

- A. Receive, inspect, handle, and store panelboards according to NECA 407.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **2.02 INSTALLATION**

- A. Install panelboards and accessories according to NECA 407.
- B. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Section 033000 "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 full perimeter of base.
  - 2. For panelboards, 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 panelboards.
  - 5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

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- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- E. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated. Mounting height of Over Current Protective Devices shall be 6"7" above finished floor to the center of the grip of device operating handle unless a lower height is indicated or required by code.
- F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- G. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
- H. Install filler plates in unused spaces.
- I. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- J. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- K. Comply with NECA 1.

## **2.03 IDENTIFICATION**

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

## **2.04 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.



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- 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 panelboard bus, 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 panelboard. 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 panelboard 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.
- F. Panelboards will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

## **2.05 ADJUSTING**

- A. Adjust moving parts and operable component to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated in Section 26 05 72 "Overcurrent Protective Device Coordination Study."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
  - 1. Measure as directed during period of normal system loading.
  - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

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4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

## **2.06 PROTECTION**

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

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## **SECTION 26 27 13 ELECTRICITY METERING**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, Including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 SUMMARY**

- A. Section includes equipment for electricity metering by the College.

#### **1.03 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.

#### **1.04 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.

#### **1.05 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

#### **1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - 1. Application and operating software documentation.
  - 2. Software licenses.
  - 3. Software service agreement.

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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.

#### **1.07 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.

#### **1.08 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, store, and handle modular meter center according to NECA 400.

#### **1.09 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 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'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 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.

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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**

### **2.01 EQUIPMENT FOR ELECTRICITY METERING BY OWNER**

- A. Manufacturers: Subject to compliance with requirements, provide products 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
  4. Electrotech Industries
- B. General Requirements for Owner's Meters:
  1. Comply with UL 1244.
  2. Meters used for billing shall have an accuracy of 0.2 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 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.
- C. 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.
- D. Kilowatt-hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.

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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.
- E. 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."
- F. Software: PC based, a product of meter manufacturer, suitable for calculation of utility cost allocation and billing.
- G. Accessories:
1. Fuses: Provide fuses to protect meters.
  2. Shunting Devices: Provide shunting devices for maintenance of meters.

### **PART 3 - EXECUTION**

#### **3.01 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.
- D. Install arc-flash labels as required by NFPA 70.
- E. 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 13 "Communications Copper Horizontal Cabling."
  3. Minimum conduit size shall be 1/2 inch (13 mm).

#### **3.02 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] [typewritten card] with occupant's name.

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### **3.03 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 College's Meter Shop Personnel. Coordinate through College'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

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## **SECTION 26 27 26 WIRING DEVICES**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 SUMMARY**

- A. Section Includes:
  - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
  - 2. USB receptacles.
  - 3. Tamper-resistant receptacles.
  - 4. Weather-resistant receptacles.
  - 5. Snap switches and wall-box dimmers.
  - 6. Solid-state fan speed controls.
  - 7. Wall-switch and exterior occupancy sensors.
  - 8. Toggle switches, 120/277 V, 20 A.
  - 9. Decorator-style devices, 20 A.
  - 10. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

#### **1.03 DEFINITIONS**

- A. AFCI: Arc-fault circuit interrupter.
- B. EMI: Electromagnetic interference.
- C. GFCI: Ground-fault circuit interrupter.
- D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- E. RFI: Radio-frequency interference.
- F. SPD: Surge Protective Device.
- G. UTP: Unshielded twisted pair.

#### **1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
  - 2. Cord and Plug Sets: Match equipment requirements.



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#### **1.05 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.
- C. Samples: One for each type of device and wall plate specified.

#### **1.06 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

#### **1.07 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.

#### **1.08 QUALITY ASSURANCE**

- A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer. Switches, receptacles and cover plates shall be of the same manufacturer.
- B. Comply with National Electrical Manufacturer's Association (NEMA) standards. Furnish products listed and classified by Underwriter's Laboratories Inc. as suitable for purpose specified and shown.
- C. Manufacturer shall have a minimum of ten (10) years experience in the production of wiring devices specified and shall have ISO 9001 and 9002 certifications.

### **PART 2 - PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
  - 1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
  - 2. Leviton Mfg. Company Inc. (Leviton).
  - 3. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

#### **2.02 GENERAL WIRING-DEVICE REQUIREMENTS**

- A. Wiring Devices, Components, and Accessories: UL Listed and labeled and marked for intended location and application.

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- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
  - 1. Connectors shall comply with UL2459 and shall be made with stranding building wire.
  - 2. Devices shall comply with the requirements in this Section.

## 2.03 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125V, 20A: Comply with NEMA WD1, NEMA WD 6 Configuration 5-20R, UL 498, and FSW-C-596.
  - 1. Products: Subject to compliance with requirements, provide one of the following manufacturers
    - a. Hubbell; HBL5361 (single), HBL5362 (duplex).
    - b. Leviton; 5361 (single), 5362 (duplex).
    - c. Pass & Seymour; 5361 (single), 5362 (duplex).
  - 2. Description: Grounded, industrial extra heavy-duty specifications grade, back- and side-wired, single-piece grounding brass strap with integral ground, impact-resistant thermoplastic nylon cover and body, smooth face, 20A, 125V, duplex, with separate grounding screw, NEMA 5-20R plug configurations and stainless-steel face plate.
- B. Weather-Resistant Duplex Receptacle, 125 V, 20 A:
  - 1. Description: Two pole, three wire, and self-grounding, integral shutters that operate only when a plug is inserted in the receptacle, square face and stainless-steel face plate.
  - 2. Configuration: NEMA WD 6, Configuration 5-20R.
  - 3. Standards: Comply with UL 498.
- C. Controlled Quad Receptacles, 125 V, 20A
  - 1. Description: Two pole, three wire and self-grounding, square face and stainless-steel face plate.
  - 2. Configuration: NEMA WD 6, Configuration 5-20R.
  - 3. Standards: Comply with UL 498.
  - 4. Marking: Shall have permanent marking per CEC 130.5 (d).
  - 5. Standards: Comply with UL 1310 and USB 3.0 devices.
- D. USB Charging Receptacles:
  - 1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system, square face and stainless-steel face plate.
  - 2. USB Receptacles: Dual, USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
  - 3. Standards: Comply with UL 1310 and USB 3.0 devices.
- E. Tamper-Resistant Duplex and USB Charging Receptacles:
  - 1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system, square face and stainless-steel face plate. Integral shutters that operate only when a plug is inserted in the line voltage receptacle.

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2. Line Voltage Receptacles: Two pole, three wire, and self-grounding; NEMA WD 6, Configuration 5-20R.
3. USB Receptacles: Dual USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
4. Standards: Comply with UL 498, UL 1310, USB 3.0 devices, and FS W-C-596.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.
6. Pedestal mounted: Flush type with one duplex receptacle and two USB ports.

## **2.04 GFCI RECEPTACLES**

### **A. General Description:**

1. Straight blade, feed-through type, square face and stainless/steel face plate.
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.
4. Include self-test feature so that the outlet is automatically tested every fifteen minutes.
5. Outlets used in coastal environments shall be suitable for such applications and shall be properly protected against the ambient conditions.

### **B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:**

1. Products: Subject to compliance with requirements, provide one of the following manufacturers:
  - a. Hubbell; GFR5352L.
  - b. Pass & Seymour; 2095.
  - c. Leviton; 7590.

## **2.05 CORD AND PLUG SETS**

### **A. Description:**

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

## **2.06 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: Smooth, high-impact thermoplastic 0.035-inch- (1-mm-) thick, satin-finished, Type 302 stainless steel 0.05-inch- (1.2-mm-) thick, anodized aluminum-
4. Material for Unfinished Spaces: Galvanized steel.

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- 5. Material for Damp Locations: Cast aluminum 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 in-use cover.
- C. Antimicrobial Cover Plates:
  - 1. Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
  - 2. Tarnish resistant.

## **2.07 FLOOR SERVICE FITTINGS**

- A. Type: Modular, flap-type, above-floor, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Rectangular, solid brass with satin finish.
- D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Per Technology documents.

## **2.08 FINISHES**

- A. Device Color:
  - 1. Wiring Devices Connected to Normal Power System: Stainless steel.
- B. Wall Plate Color: Stainless steel.

## **PART 3 - EXECUTION**

### **3.01 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.

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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 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.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, 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.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

### 3.02 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

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### **3.03 IDENTIFICATION**

- A. Comply with Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each receptacle, sensor, and switch with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

### **3.04 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  - 1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
  - 2. Test Instruments: Use instruments that comply with UL 1436.
  - 3. 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 20-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. Submit reports within two (2) weeks of completion of tests.

END OF SECTION

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## **SECTION 26 28 13 FUSES**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 SUMMARY**

- A. Section Includes:
  - 1. Cartridge fuses rated 600-V ac and less for use in enclosed switches panelboards switchboards enclosed controllers and motor-control centers.
  - 2. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
  - 3. Spare-fuse cabinets.

#### **1.03 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.
  - 5. Coordination charts and tables and related data.
  - 6. Fuse sizes for elevator feeders and elevator disconnect switches.

#### **1.04 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For fuses 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. Ambient temperature adjustment information.
  - 2. Current-limitation curves for fuses with current-limiting characteristics.

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3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
4. Coordination charts and tables and related data.

#### **1.05 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.

#### **1.06 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.

#### **1.07 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), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

#### **1.08 COORDINATION**

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

### **PART 2 - PRODUCTS**

#### **2.01 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.



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## **2.02 CARTRIDGE FUSES**

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

## **2.03 PLUG FUSES**

- A. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

## **2.04 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.

## **2.05 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**

## **3.01 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.

## **3.02 FUSE APPLICATIONS**

- A. Cartridge Fuses:

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1. Service Entrance: Class L, fast acting.
2. Feeders: Class L, fast acting.
3. Motor Branch Circuits: Class RK1, time delay.
4. Other Branch Circuits: Class RK1, time delay.
5. Control Circuits: Class CC, fast acting or time delay.

B. Plug Fuses:

1. Motor Branch Circuits: Edison-base type, single-element time delay.
2. Other Branch Circuits: Edison-base type, single-element fast acting.

**3.03 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).

**3.04 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

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## **SECTION 26 28 16 ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

### **PART 1 - GENERAL**

#### **1.01 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.

#### **1.02 SUMMARY**

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Nonfusible switches.
  - 3. Enclosures.

#### **1.03 DEFINITIONS**

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

#### **1.04 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 and the unit will be fully operational after the seismic event."

#### **1.05 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. Include evidence of NRTL listing for series rating of installed devices.
  - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

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6. Include 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.
- 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.

#### **1.06 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.

#### **1.07 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 23 "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.

#### **1.08 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.

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- 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.

#### **1.09 PROJECT CONDITIONS**

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
  - 2. Altitude: Not exceeding 6600 feet.
- 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 Architect Construction Manager Owner no fewer than seven days in advance of proposed interruption of electric service.
  - 2. Indicate method of providing temporary electric service.
  - 3. Do not proceed with interruption of electric service without Architect's Construction Manager's Owner'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**

#### **2.01 FUSIBLE SWITCHES**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 2. Siemens Energy & Automation, Inc.
  - 3. Square D; a brand of Schneider Electric.

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- B. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified 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.

## 2.02 NONFUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 2. Siemens Energy & Automation, Inc.
  - 3. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 240-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. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

## 2.03 RECEPTACLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 2. Siemens Energy & Automation, Inc.
  - 3. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy-Duty, Single-Throw Fusible Switch: 240 and 600-V ac, 30, 60, 100 A; 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; interlocked with cover in closed position.

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- C. Type HD, Heavy-Duty, Single-Throw Non-fusible Switch: 24,0 600-V ac, 30, 60, 100 A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.
- E. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

## **2.04 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**

### **3.01 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.

### **3.02 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 260548 "Vibration and Seismic Controls for Electrical Systems."
- 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 NFPA 70 and NECA 1.

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### **3.03 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.

### **3.04 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 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.



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**3.05 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 72 "Overcurrent Protective Device Coordination Study."

END OF SECTION

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## **SECTION 26 51 00 LED INTERIOR LIGHTING**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 SUMMARY**

- A. Section includes the following types of LED luminaires:
  - 1. Exit signs.
  - 2. Downlight.
  - 3. Recessed troffers.
  - 4. Strip light.
  - 5. Suspended, linear.
  - 6. Suspended, nonlinear.
- B. Related Requirements:
  - 1. Section 26 09 43 network lighting control systems with low-voltage control wiring or data communication circuits.

#### **1.03 DEFINITIONS**

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

#### **1.04 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Arrange in order of luminaire designation.
  - 2. Include data on features, accessories, and finishes.

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3. Include physical description and dimensions of luminaires.
  4. Include emergency lighting units, including batteries and chargers.
  5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
  6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project, IES LM-79 and IES LM-80.
    - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
    - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- B. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.
  2. Include details of luminaire 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. Samples: For each luminaire and for each color and texture with standard factory-applied finish.
- D. Samples for Initial Selection: For each type of luminaire with custom factory-applied finishes.
1. Include Samples of luminaires and accessories involving color and finish selection.
- E. Samples for Verification: For each type of luminaire.
1. Include Samples of luminaires and accessories to verify finish selection.
- F. Product Schedule: For luminaires and lamps, refer to light fixture schedule on plans.

## 1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) 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. Luminaires.
  2. Suspended ceiling components.
  3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
  4. Structural members to which equipment and luminaires will be attached.
  5. Initial access modules for acoustical tile, including size and locations.
  6. Items penetrating finished ceiling, including the following:
    - a. Other luminaires.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.

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- e. Access panels.
  - f. Ceiling-mounted projectors.
- 7. Moldings.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Data: For luminaires, 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.
- D. Product Certificates: For each type of luminaire Product Test Reports: For each type of luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency and as follows:
  - 1. Test reports complying with LM-79 (IES approved method for electrical and photometric measurements of Solid-State Lighting) providing total luminous flux, luminous intensity distribution, electrical power characteristics, luminous efficacy and color characteristics (CRI, CCT) shall be submitted.
  - 2. Test reports complying with LM-80 (IES approved standard for measuring lumen maintenance of LED light sources) providing lumen maintenance of LED light sources shall be submitted.
  - 3. ISTMT (IN SITU TEMPERATURE MEASUREMENT TEST) – It is the measure of the LED source case temperature within the LED system (luminaire or lamp or it is the temperature of the LED within the luminaire. This measurement should be performed according to the temperature measurement point (TMP) indicated by the particular LED package manufacturer. The temperature measured within the luminaire shall be within the temperature of the LM-80-08 LED source report.
  - 4. All LED lifetime projections shall be made per TM-21-11 (approved method for taking LM-80 data and making useful LED lifetime projections).
- E. Sample warranty.

#### **1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
  - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

#### **1.07 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: Ten for every 100 of each type and rating installed. Furnish at least one of each type.

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2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

#### **1.08 QUALITY ASSURANCE**

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. 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 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- E. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
  1. Obtain Architect's approval of luminaires in mockups before starting installations.
  2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### **1.09 DELIVERY, STORAGE, AND HANDLING**

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

#### **1.10 WARRANTY**

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

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## **PART 2 - PRODUCTS**

### **2.01 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.

### **2.02 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
  - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."
- C. Ambient Temperature: 41 to 104 deg F (5 to 40 deg C).
  - 1. Relative Humidity: Zero to 95 percent.
- D. Altitude: Sea level to 1000 feet.

### **2.03 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)

### **2.04 LUMINAIRE 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. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels 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 characteristics:
    - a. "USE ONLY" and include specific lamp type.
    - b. Lamp diameter, shape, size, wattage, and coating.
    - c. CCT and CRI.

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- C. Recessed luminaires shall comply with NEMA LE 4.
- D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- E. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- F. California Title 24 compliant.

## **2.05 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.

## **2.06 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. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

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## **2.07 DOWNLIGHT**

### **A. Lamp:**

1. Minimum allowable efficacy of 80 lm/W.
2. CRI of minimum 80. CCT of 4000K.
3. Rated lamp life of 50,000 hours to L70.
4. Dimmable from 100 percent to 0 percent of maximum light output.
5. Internal driver.
6. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

### **B. Housings:**

1. Extruded-aluminum, stainless steel, or per plans, Steel housing and heat sink.
2. Clear, anodized, powder-coat finish.
3. Universal mounting bracket.
4. Integral junction box with conduit fittings.

### **C. 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.

### **D. Additional Diffusers and Globes:**

1. Fixed, Adjustable lens.
2. Spot, Medium, Wide light distribution.

### **E. Standards:**

1. Recessed luminaires shall comply with NEMA LE 4.

## **2.08 RECESSED LUMINAIRES**

### **A. Lamp:**

1. Minimum allowable efficacy of 80 lm/W.
2. CRI of minimum 80. CCT of 4000K.
3. Rated lamp life of 50,000 hours to L70.
4. Dimmable from 100 percent to 0 percent of maximum light output.
5. Internal driver.
6. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

### **B. Housings:**

1. Extruded-aluminum, stainless steel, or per plans, Steel housing and heat sink.
2. Clear, anodized, powder-coat finish.
3. Universal mounting bracket.
4. Integral junction box with conduit fittings.

### **C. 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



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doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

D. Additional Diffusers and Globes:

1. Fixed, Adjustable lens.
2. Spot, Medium, Wide light distribution.

E. Standards:

1. Recessed luminaires shall comply with NEMA LE 4.

## 2.09 STRIP LIGHT

A. Lamp:

1. Minimum allowable efficacy of 80 lm/W.
2. CRI of minimum 80. CCT of 4000K.
3. Rated lamp life of 50,000 hours to L70.
4. Dimmable from 100 percent to 0 percent of maximum light output.
5. Internal driver.
6. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

B. Housings:

1. Extruded-aluminum, stainless steel, or per plans housing and heat sink.
2. Clear, anodized, powder-coat, finish.
3. With integral mounting provisions.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping of luminaire without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

## 2.10 SUSPENDED, LINEAR AND NONLINEAR

A. Lamp:

1. Minimum allowable efficacy of 80 lm/W.
2. CRI of minimum 80. CCT of 4000K.
3. Rated lamp life of 50,000 hours to L70.
4. Dimmable from 100 percent to 0 percent of maximum light output.
5. Internal driver.
6. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

B. Housings:

1. Extruded-aluminum, stainless steel, or per plans housing and heat sink.
2. Clear, anodized, powder-coat, finish.
3. Universal mounting bracket.
4. Integral junction box with conduit fittings.

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- C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

## **2.11 MATERIALS**

### **A. Metal Parts:**

- 1. Free of burrs and sharp corners and edges.
- 2. Sheet metal components shall be steel unless otherwise indicated.
- 3. Form and support to prevent warping and sagging.

### **B. Steel:**

- 1. ASTM A 36/A 36M for carbon structural steel.
- 2. ASTM A 568/A 568M for sheet steel.

### **C. Stainless Steel:**

- 1. Manufacturer's standard grade.
- 2. Manufacturer's standard type, ASTM A 240/240 M.

### **D. Galvanized Steel: ASTM A 653/A 653M.**

### **E. Aluminum: ASTM B 209.**

## **2.12 METAL FINISHES**

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

## **2.13 LUMINAIRE SUPPORT**

- A. Comply with requirements in 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 steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gauge.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

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## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 TEMPORARY LIGHTING**

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

### **3.03 INSTALLATION**

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
  - 1. Sized and rated for luminaire weight.
  - 2. Able to maintain luminaire position after cleaning and relamping.
  - 3. Provide support for luminaire without causing deflection of ceiling or wall.
  - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaires:
  - 1. Secured to outlet box.
  - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
  - 3. Trim ring flush with finished surface.
- F. Wall-Mounted Luminaires:
  - 1. Attached to structural members in walls Attached to a minimum 20-gauge backing plate attached to wall structural members.
  - 2. Do not attach luminaires directly to gypsum board.
- G. Suspended Luminaires:
  - 1. Ceiling Mount:

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- a. Two 5/32-inch diameter aircraft cable supports adjustable to 10 feet in length.
    - b. Pendant mount Four-point pendant mount with 5/32-inch diameter aircraft cable supports adjustable to 10 feet in length.
    - c. Hook mount.
  - 2. Pendants and Rods: Where longer than 24 inches, brace to limit swinging.
  - 3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
  - 4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod or wire support for suspension for each unit length of luminaire chassis, including one at each end.
  - 5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- H. Ceiling-Grid-Mounted Luminaires:
- 1. Secure to any required outlet box.
  - 2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
  - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.
- I. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

### **3.04 IDENTIFICATION**

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

### **3.05 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
  - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

### **3.06 STARTUP SERVICE**

- A. Comply with requirements for startup specified in Section 26 09 43 "Addressable-Luminaire Lighting Controls."
- B. Comply with requirements for startup specified in Section 26 09 43 "Network Lighting Controls".

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### **3.07 ADJUSTING**

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
  2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION

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## **SECTION 26 56 00 LED EXTERIOR LIGHTING**

### **PART 1 - GENERAL**

#### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.02 SUMMARY**

- A. Section Includes:
  - 1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
  - 2. Luminaire supports.
  - 3. Luminaire-mounted photoelectric relays.
- B. Related Requirements:
  - 1. Section 26 09 43 network lighting control systems with low-voltage control wiring or data communication circuits.

#### **1.03 DEFINITIONS**

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

#### **1.04 ACTION SUBMITTALS**

- A. Product Data: For each type of luminaire.
  - 1. Arrange in order of luminaire designation.
  - 2. Include data on features, accessories, and finishes.
  - 3. Include physical description and dimensions of luminaire.
  - 4. Lamps include life, output (lumens, CCT, and CRI), and energy-efficiency data.
  - 5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the

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luminaire as applied in this Project and testing procedures and criteria required by IES LM-79 and LM-80.

- a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
  - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
6. Wiring diagrams for power, control, and signal wiring.
  7. Photoelectric relays.
  8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
- B. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.
  2. Include details of luminaire 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. Sustainable Design Submittals:
1. "BUG ratings" Light Pollution Reduction for both uplight and light trespass.

#### PRODUCT DATA: INDICATING LUMINAIRE IS CERTIFIED BY ENERGY STAR

- D. Samples: For each luminaire and for each color and texture indicated with factory-applied finish.
- E. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.
- F. Delegated-Design Submittal: For luminaire supports.
1. Include design calculations for luminaire supports and seismic restraints.

### 1.05 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. Luminaires.
  2. Structural members to which equipment and luminaires will be attached.
  3. Underground utilities and structures.
  4. Existing underground utilities and structures.
  5. Above-grade utilities and structures.
  6. Existing above-grade utilities and structures.
  7. Building features.
  8. Vertical and horizontal information.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.

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- C. Seismic Qualification Data: For luminaires, 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.
- D. Product Certificates: For each type of the following:
1. Luminaire.
  2. Photoelectric relay.
- E. Test reports complying with LM-79 (IES approved method for electrical and photometric measurements of Solid-State Lighting) providing total luminous flux, luminous intensity distribution, electrical power characteristics, luminous efficacy and color characteristics (CRI, CCT) shall be submitted. Test reports complying with LM-80 (IES approved standard for measuring lumen maintenance of LED light sources) providing lumen maintenance of LED light sources shall be submitted.
- F. ISTMT (IN SITU TEMPERATURE MEASUREMENT TEST) – It is the measure of the LED source case temperature within the LED system (luminaire or lamp or it is the temperature of the LED within the luminaire. This measurement should be performed according to the temperature measurement point (TMP) indicated by the particular LED package manufacturer. The temperature measured within the luminaire shall be within the temperature of the LM-80-08 LED source report.
- G. All LED lifetime projections shall be made per TM-21-11 (approved method for taking LM-80 data and making useful LED lifetime projections).
- H. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency as follows:
1. Test reports complying with LM-79 (IES approved method for electrical and photometric measurements of Solid-State Lighting) providing total luminous flux, luminous intensity distribution, electrical power characteristics, luminous efficacy and color characteristics (CRI, CCT) shall be submitted.
  2. Test reports complying with LM-80 (IES approved standard for measuring lumen maintenance of LED light sources) providing lumen maintenance of LED light sources shall be submitted.
  3. ISTMT (IN SITU TEMPERATURE MEASUREMENT TEST) – It is the measure of the LED source case temperature within the LED system (luminaire or lamp or it is the temperature of the LED within the luminaire. This measurement should be performed according to the temperature measurement point (TMP) indicated by the particular LED package manufacturer. The temperature measured within the luminaire shall be within the temperature of the LM-80-08 LED source report.
  4. All LED lifetime projections shall be made per TM-21-11 (approved method for taking LM-80 data and making useful LED lifetime projections).
- I. Source quality-control reports.
- J. Sample warranty.



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## **1.06 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For luminaire to include in operation and maintenance manuals.
  - 1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
  - 2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

## **1.07 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: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: of each type and rating installed. Furnish at least one of each type.
  - 3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

## **1.08 QUALITY ASSURANCE**

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. 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 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- F. Mockups: For exterior luminaires, complete with power and control connections.
  - 1. Obtain Architect's approval of luminaires in mockups before starting installations.
  - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
  - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

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#### **1.09 DELIVERY, STORAGE, AND HANDLING**

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

#### **1.10 FIELD CONDITIONS**

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

#### **1.11 WARRANTY**

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures, including luminaire support components.
    - b. Faulty operation of luminaires and accessories.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 2. Warranty Period: 5-years from date of Substantial Completion.

### **PART 2 - PRODUCTS**

#### **2.01 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
  - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

#### **2.02 LUMINAIRE 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. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

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- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. UL Compliance: Comply with UL 1598 and listed for wet location.
- E. Lamp base complying with ANSI C81.61 or IEC 60061-1.
- F. Bulb shape complying with ANSI C79.1.
- G. CRI of minimum 80. CCT of 4000K.
- H. L70 lamp life of 50,000 hours.
- I. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- J. Internal driver.
- K. Nominal Operating Voltage: 277 V ac, 12 V dc, 24 V dc.
- L. In-line Fusing: On the primary for each luminaire.
- M. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.
- N. Source Limitations: Obtain luminaires from single source from a single manufacturer.
- O. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

## **2.03 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 and off at 4.5 to 10 fc 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.

## **2.04 LUMINAIRE TYPES**

- A. Area and Site:
  - 1. Luminaire Shape: Round
  - 2. Mounting: Pole
  - 3. Luminaire-Mounting Height: See plans.
  - 4. Distribution: See plans.
- B. Bollard:

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1. Shape: Round
2. Height Above Finished Grade: See plans.
3. Overall Height: See plans
4. Diameter: See plans.
5. Mounting: 3-point cast aluminum base.
6. Distribution: See plans.
7. Diffusers and Globes: per plans

## **MATERIALS**

- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.
- E. 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.
- F. Diffusers and Globes:
1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
  2. Glass: Annealed crystal glass unless otherwise indicated.
  3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- G. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- H. 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.
- I. Housings:
1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
  2. Provide filter/breather for enclosed luminaires.
- J. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. 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 characteristics:
    - a. "USE ONLY" and include specific lamp type.
    - b. Lamp diameter, shape, size, wattage and coating.
    - c. CCT and CRI for all luminaires.

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## **2.05 FINISHES**

- A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. 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.
- C. 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 requirements; 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.
- D. 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, 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 or SSPC-SP 8.
  - 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: See plans, or as selected by Architect.

## **2.06 LUMINAIRE SUPPORT COMPONENTS**

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine walls, roofs, ceilings for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 TEMPORARY LIGHTING**

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

### **3.03 GENERAL INSTALLATION REQUIREMENTS**

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Install lamps in each luminaire.
- D. Fasten luminaire to structural support.
- E. Supports:
  - 1. Sized and rated for luminaire weight.
  - 2. Able to maintain luminaire position after cleaning and relamping.
  - 3. Support luminaires without causing deflection of finished surface.
  - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- F. Wall-Mounted Luminaire Support:
  - 1. Attached to structural members in walls, Attached to a minimum 1/8 inch backing plate attached to wall structural members.
- G. Wiring Method: Install cables in raceways. Conceal raceways and cables.
- H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.
- I. Coordinate layout and installation of luminaires with other construction.
- J. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
- K. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and Section 26 05 33 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

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### **3.04 BOLLARD LUMINAIRE INSTALLATION:**

- A. Align units for optimum directional alignment of light distribution.
  - 1. Install on concrete base with top above finished grade or surface at luminaire 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."

### **3.05 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES**

- A. Aim as indicated on Drawings.
- B. Install on concrete base with top 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."

### **3.06 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 thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### **3.07 IDENTIFICATION**

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

### **3.08 FIELD QUALITY CONTROL**

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
  - 2. Verify operation of photoelectric controls.
- C. Illumination Tests:
  - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
    - a. IES LM-5.
    - b. IES LM-50.
    - c. IES LM-52.

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- d. IES LM-64.
  - e. IES LM-72.
- 2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- D. Luminaire will be considered defective if it does not pass tests and inspections.
- E. 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.

### **3.09 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

### **3.10 ADJUSTING**

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
  - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
  - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  - 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION



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## **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. Backbone Cables: Cables linking the BDF and the IDF.
  5. Horizontal Cables: Cables linking the IDF to each workstation outlet.
  6. External Cables: Cables that link the building to external connection point(s) and/or other building(s). These cables are considered to be Outside Plant (OSP).
  7. Station Cables: Cables linking workstation outlet to active equipment.
  8. Client: MiraCosta Community College District
  9. Architect: Per project
  10. Consultant: Project consultant
  11. Bidder: A company invited to bid for the works
  12. Installer/Contractor: The Company installing the equipment as defined in this specification
  13. 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.

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#### **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 on 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 so as 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 EIA/TIA 606 for the Administration of the Telecommunications Infrastructure for Commercial Buildings.

#### **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, 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 anytime 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

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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/EIA/TIA 568-1.D Commercial Building Telecommunications Wiring Standard
  - 4. ANSI/EIA/TIA 569-D Commercial Building Standard for Telecommunications Pathways and Spaces
  - 5. ANSI/EIA/TIA 606-C The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
  - 6. ANSI/EIA/TIA 607-C Commercial Building Grounding and Bonding Requirements for Telecommunications
  - 7. Building Industry Consulting Service International (BICSI) publications:
    - a. Information Technology Systems Installation Methods Manual (ITSIMM), 7<sup>th</sup> Edition
    - b. Telecommunications Distribution Methods Manual (TDMM), 14<sup>th</sup> Edition
    - c. Outside Plant Design Reference Manual (OSPDRM), 6<sup>th</sup> 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
- 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 located 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.

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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 singleline 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

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- 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 laminated copies of as-builts on site in each Technology Room.
3. Final Test Results
  - a. Test results for each cable indicating tests performed, results obtained and values measured.
4. All documentation and drawings shall be provided in an un-locked acceptable electronic format. AutoCAD (at least R14) for drawings, MS Excel (for schedules) and supplied on a USB Drive.

## PART 2 PRODUCTS

### 2.1 HORIZONTAL CROSSCONNECT TERMINATED COPPER CABLING

- A. Provide Belden **DataTwist 4800 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 plenum-rated (CMP). 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 EIA/TIA 568-C.2. This covers all Category 6 components installed as a part of the installation.
- C. Voice copper cables shall be white in color.

### 2.2 HORIZONTAL INTERCONNECT TERMINATED COPPER CABLING

- A. Data Outlets: Provide Belden **DataTwist 4800 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 plenum-rated (CMP). 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 high-performance copper cabling system shall meet or exceed the performance specifications for Category 6 cabling as detailed in EIA/TIA 568-1.D This covers all Category 6 components installed as a part of the installation.
  2. Data copper cables shall be black in color.
- B. Wireless Access Points: Provide Belden 10GX 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 plenum-rated (CMP). 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 high-performance copper cabling system shall meet or exceed the performance specifications for Category 6A cabling as detailed in EIA/TIA 568-1.D This covers all Category 6A components installed as a part of the installation.
  2. Wireless Access Point copper cables shall be blue in color.
- C. Exterior 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.

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## **2.3 LINK COPPER CABLING**

- A. Provide Belden 10GX or 10GXW, 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 plenum-rated (CMP). 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 6A cabling as detailed in EIA/TIA 568-1.D This covers all Category 6A components installed as a part of the installation.
- C. Link copper cables colors shall be verified with the Owner prior to procurement of materials.

## **2.4 WORK AREA CONNECTORS**

- A. Provide Belden GigaFlex 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. Provide additional 15% spare work area connectors.

## **2.5 PATCH PANELS**

- A. Data Patch Panels. Provide Belden GigaFlex PS6+ or 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 (AX101613) 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. Link Patch Panels. Provide Belden CAT 6A or approved equal from Siemon or Commscope Systimax to match cabling manufacturer for compliance with the end-to-end system warranty, Modular 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. Provide Category 6A connectors, colors to be verified with Owner, for each cable installed.
  - 5. Allow for labeling of each individual connector.
  - 6. Allow any individual cable to be terminated or otherwise handled without disturbing other cables.

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## 2.6 PATCH CORDS

- A. Provide two high performance copper patch cords per telecommunications outlet. 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 feet in length and black in color
  - 2. 10% of the patch cords shall be 3 feet in length and black in color
  - 3. 40% of the patch cords shall be 7 feet in length and black in color
  - 4. 20% of the patch cords shall be 11 feet in length and black in color
- B. 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 Systimax 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. For additional combination multi-service floor box and poke-through information, refer to MCCCD standards Appendix Section 6-3.

## 2.8 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.



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- 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 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 ½" diameter. The labels shall 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.

## **2.9 CABLE SUPPORTS**

- A. Provide J-Hooks to support communications cables running in the ceiling void in locations where cable tray and/or conduit is not provided. J-Hooks to be B-Line, Mono Systems 'The Hook', Caddy 'Cable Cat' or approved equal.

## **2.10 MULTI-SERVICE POWER/DATA FLOOR BOX**

- A. Provide Legrand Wiremold RFB2 two-compartment recessed floor box for power and data services.
- B. Include flush lid configured with color and trim material coordinated with the project architect for matching aesthetics.

## **2.11 MULTI-SERVICE POWER/DATA/AUDIOVISUAL FLOOR BOX**

- A. 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 of floor box and power on the opposite side. Data and Audiovisual conduits to be separate for dedicated services cabling.
- B. Include flush lid configured for carpet/tile insert or solid surface with color and trim material coordinated with the project architect for matching aesthetics.



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## **2.12 MULTI-SERVICE POWER/DATA/AUDIOVISUAL IN-WALL BOX (FLUSH)**

- A. 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.
- B. Include white cover plate and prime/paint as required to match the wall finish schedule in coordination with the project architect for matching aesthetics.

## **2.13 EXTERNAL WIRELESS ENCLOSURE**

- A. Provide outdoor wireless access point and antenna concealment shroud.
  - 1. Model 3001-00 as manufactured by Oberon, a division of Chatsworth Products, Inc.
  - 2. Design: Rugged ABS plastic vanity cover, hinged to universal equipment mounting panel.
  - 3. Performance: UV resistant vanity cover is virtually transparent to wireless signal
  - 4. Construction: Stainless Steel 16 ga. wall mounting brackets and hardware,
  - 5. ABS mounting panel, white ABS plastic cover with UV cap
  - 6. Size: 14.25 x 22 x 11 in.
  - 7. Prime and paint as required to match building finish - use RF-transparent water-based paint as recommended by MFG.

## **2.14 CODE BLUE PHONE**

- A. Provide new wall mounted Code Blue Phone to replace existing Emergency Phone location as shown on the plans.
  - 1. Equipment shall be CB 4U Signature Help Point and shall include separate wall mounted blue beacon and Public Address accessory.
  - 2. Unit shall be blue in color with reflective white lettering indicating "EMERGENCY". Paint to have protective gloss coating for additional protection from salt air.
  - 3. Unit shall have the IP500 IP intercom with "PUSH FOR HELP" button in the primary opening. Unit shall include a custom camera cutout for the secondary opening. Both opening plates shall have a clear coat for additional weatherized protection.
  - 4. Unit shall include the battery backup for the IP500 Intercom.
  - 5. Unit shall include the separate top "remote" Public Address and blue light stroke/ beacon accessory painted to match unit.

## **PART 3 EXECUTION**

### **3.1 HORIZONTAL CABLING AND COMPONENTS**

- A. Horizontal Cabling
  - 1. Provide one four-pair high performance plenum-rated horizontal cable running from each work area connector to the patch panels located in the Technology Room serving that outlet. Terminate all four pairs of each end of each cable with an RJ45 communications connector using the EIA/TIA 568B.2 termination scheme.
- B. 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 and shall match the electrical faceplate color. Any unused faceplate opening shall contain a matching blanking insert.

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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 to house (4) RJ45 work area jacks as shown on the drawings. The faceplate shall fit over a modular raceway.
4. Floorbox Outlet. Each Floorbox outlet will be a flush-mounted modular faceplate to house (4) RJ45 work area jacks as shown on the drawings.
5. Audiovisual Station Outlet. Floor or wall to have 6 minimum (coordinate with MCCCCD Media Services for actual quantity by system for a one-to-one networked device correlation).

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### 3.2 HIGH-PERFORMANCE COPPER LINK CABLING

- A. High Performance Copper Link Cable
  - 1. Provide Category 6A high performance 4-pair cables running between each of the Telecommunications Rooms, as shown on the drawings. The high-performance cables shall not exceed 90 meters.
  - 2. Terminate all four pairs of each end of each cable with an RJ45 communications connector fitted in a rack-mounted patch panel using the EIA/TIA 568B termination scheme. Label each connector with the link cable number.

### 3.3 TECHNOLOGY INFRASTRUCTURE

- A. Conduit, And J-Hook Installation
  - 1. Where shown on the drawings, provide solid metal conduit to protect cable runs. 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. Conduit sleeves shall be sized and fire-stopped per all applicable national and local electric and fire codes.
  - 3. 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.
  - 4. Install the appropriate seismic transverse and longitudinal bracing per any local codes and the current NUSIG (National Uniform Seismic Installation Guidelines).

### 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.

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- F. Use plenum-rated Velcro tie wraps in plenum spaces.
- G. Reinstall 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 manufacturers 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 EIA/TIA 568-B.2. 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. Labels shall be machine generated, not hand-written, and placed within 12 inches of each end of each cable.

### **3.5 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.

### **3.6 TESTING**

- A. General Instructions.

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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 of 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 a 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 to 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 than the sample will be expanded to 20% and be re-tested by the contractor under the observation of the customer. If the variances continue than 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 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. On the fault being 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 site.

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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. Telephone System External and Backbone Cabling
  1. Test each Telephone System Backbone and External Cable and its associated patch frame connectors. Carry out the following tests on every pair of every telephone system feeder and external cable:
    - a. Wire map
    - b. Length
    - c. Insertion Loss
- C. 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)
- D. 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.

**END OF SECTION 27 10 00**

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## **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.

#### **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 10 00 & 28 00 00 - Communications & Security Specifications

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. General Performance
  - 1. The intent of this specification is to provide a hybrid IP and 70v classroom bell and paging system. Classrooms speakers must IP based and have the ability to control each and every speaker individually. Outside and common areas must be grouped together in a logical manor and homerun back to the MDF.
    - a. Speakers located in classrooms must have the ability to be controlled individually
    - b. Speakers located in common areas and outside must be grouped together in a logical manor
  - 2. The entire classroom bell and paging system shall be controllable from a Microsoft Windows™ based computer
  - 3. 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.

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3. The paging processor shall be compliant with SingleWire Informacast™ systems to maintain communications continuity with the District deployed legacy notification system.
- 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.



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## **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.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Acceptable Manufacturer: Compliant with the Singlewire InformaCast™ system to maintain communications continuity with the District deployed legacy notification 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. Systems having more than one speaker inside a classroom connected to a speaker channel are not acceptable.
- C. The IP Paging System on campus is existing, and it is the intent for this project that the installed paging speakers for this building will tie into the existing paging system. Contractor shall confirm with campus that the quantity of licenses required will be obtained to add speakers for this project.
  - 1. Software and Licenses shall be Owner Supplied Contractor Installed and Programmed
  - 2. Design Basis: Atlas Sound InformaCast
  - 3. IP Loudspeaker (Wall Mounted in exterior locations) – The loudspeaker shall provide coverage of general areas as shown on the contract documents.
  - 4. Design Basis: Atlas Sound
  - 5. IP Loudspeaker (Exterior Walls) – The loudspeaker shall provide coverage of general exterior areas as shown on Contract documents.
  - 6. Design Basis: Atlas Sound IP-HVP with flush in wall box IP-FEST-HVP
  - 7. IP Speaker cabling shall conform to College Standard Cat 6 cable as described in 27 15 00

### **2.2 SYSTEM COMPONENTS**

- A. General System Overview: The paging system shall be a PoE networked system. The system shall be comprised of:
  - 1. Microsoft Windows™-based computer running management software
  - 2. VoIP phone or paging microphone
  - 3. IP-to-Analog Controller and Mixer/Amplifier(s) as required for legacy equipment interface (existing building conditions only)
  - 4. Loudspeaker assemblies

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5. PoE network switch(es)
  6. Cable assemblies
  7. Dimensions: Width 19.0 inches Height 1.75 inches; 1 RU
  8. Network communication components
  9. 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. 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 telcom (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.

## 2.3 SOFTWARE CONTROL

- A. The software shall provide:
1. Operation on Microsoft Windows™ operating system
  2. The ability to adjust any individual speaker without affecting adjacent speakers
  3. The ability to define and adjust groups of speakers
  4. Paging volume and equalization
  5. The ability to route and mix network audio channels to any individual speaker
  6. The ability to create and adjust zones for paging and music
  7. Reporting of all system settings
  8. Backup and restore functions for all system settings
  9. Network diagnostics
  10. Panic button integration
  11. 911 Alerting
  12. Building lockdown, evacuation & emergency notification
  13. Pre-recorded announcements

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- 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 MCCCCD'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 MCCCCD'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

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- 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.
- 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, 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**

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## **SECTION 27 51 16 AUDIOVISUAL EQUIPMENT - MOUNTS**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes: This Section specifies stationary ceiling mount and equipment enclosure and related accessories for ceiling installation of multimedia projectors.

#### **1.2 ACTION SUBMITTALS**

- A. General: Submit listed submittals in accordance with Contract.
- B. Product Data: Submit for specified products as follows:
  - 1. Manufacturer's product data, including manufacturer=s technical data sheet(s).
  - 2. Catalog pages illustrating products to be incorporated into project.
- C. Shop Drawings: Indicate information on shop drawings as follows:
  - 1. Layout indicating locations.
  - 2. Dimensions.
  - 3. Installation details.
  - 4. Anchorage details.
  - 5. Manufacturer's recommendations for accessories and mounting kits.

#### **1.3 INFORMATION SUBMITTALS**

- A. General: Submit listed submittals in accordance with Contract Conditions.
- B. Manufacturer=s Instructions: Submit manufacturer=s installation instructions.
- C. Source Quality Control: Submit documentation verifying that components and materials specified in this Section are from single manufacturer.
- D. Mounting details per field conditions.
- E. Quantity / type per room (including assigned room number).

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data:
  - 1. Submit operation and maintenance data for installed products.
- B. Warranty Documentation: Submit warranty documents specified.
- C. Keys for enclosure lock.

#### **1.5 QUALITY ASSURANCE**

- A. Qualifications:
  - 1. Manufacturer:
    - a. 5 years of experience manufacturing components similar to or exceeding requirements of project.
    - b. Having sufficient capacity to produce and deliver required materials without

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- causing delay in work.
- c. Capable of providing field service representation during construction.
- 2. Installer: Acceptable to manufacturer, experienced in performing work of this section and has specialized in installation of work similar to that required for this project.

## **1.6 DELIVERY, STORAGE & HANDLING**

- A. Delivery and Acceptance Requirements:
  - 1. Deliver material in accordance with project guidelines and in accordance with manufacturer=s written instructions.
  - 2. Deliver materials in manufacturer=s original packaging with identification labels intact and in sizes to suit project.
- B. Storage and Handling Requirements:
  - 1. Store materials protected from exposure to harmful weather conditions and at temperatures recommended by manufacturer.
- C. Packaging Waste Management:
  - 1. Separate waste materials for recycling.
  - 2. Remove packaging materials from site and dispose of at appropriate recycling facilities.
  - 3. Collect and separate cardboard for disposal for recycling.
  - 4. Fold metal and plastic banding, flatten and place in designated area for recycling.

## **PART 2 PRODUCTS**

### **2.1 CEILING PROJECTOR MOUNT**

- A. Description:
  - 1. Mount shall be adjustable to accommodate multiple models of projectors of up to 75 lbs. in weight.
  - 2. Compatibility:
    - a. Ensure components and materials are compatible with specified accessories and adjacent materials. Mate all components to standard 1-1/2" NPT couplers and devices.
- B. Manufacturer: Premier Mounts or Peerless AV
  - 1. Single Source Responsibility: Provide like components and materials specified in this section from a single manufacturer.
- C. Model: Shall be Peerless CMJ450
- D. Provide with 3" extension Column Chief CMS003
- E. Confirm final model with College.

### **2.2 UNIVERSAL PROJECTOR MOUNT**

- A. Description:
  - 1. Mount shall be adjustable to accommodate multiple models of projectors of up to 75 lbs. in weight.
  - 2. Compatibility:
    - a. Ensure components and materials are compatible with specified accessories and adjacent materials. Mate all components to standard 1-1/2" NPT couplers and devices.

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- B. Model: Shall be Peerless PRGSS UNIV.
- C. Contractor to confirm with College on final mount.
- D. Design/Performance Criteria:
  - 1. Pitch: Plus, or minus 15 degrees.
  - 2. Roll: Plus, or minus 20 degrees.
  - 3. Swivel: 360 degrees.
  - 4. Load Capacity: To 50 lb. (23 kg).
- E. Operation:
  - 1. Allows alignment of projector lens to the pivot axes.
  - 2. Allows fine tuning of the image to the viewing screen.
- F. Mounting:
  - 1. Mounts to ceiling.
  - 2. Include tamper resistant fasteners for projector and mount.
- G. Materials:
  - 1. Mount: Mild steel.
  - 2. Grooved Coupling: 1 1/2 inch (38.1 mm) NPT steel half pipe.
  - 3. U-Joint, Legs: 14 gauge formed steel.
  - 4. Pitch Bracket, Locking Ring, Base Disk: 11 gauge steel.
- H. Finish: Powder coated WHITE to match ceiling tiles.

## 2.3 PROJECTOR LOCK

- A. Description:
  - 1. Mount shall be adjustable to accommodate multiple models of projectors of up to 75 lbs. in weight.
  - 2. Compatibility:
    - a. Ensure components and materials are compatible with specified accessories and adjacent materials. Mate all components to standard 1-1/2" NPT couplers and devices.
- B. Manufacturer: BMS
- C. Model: Shall be BMS model #LCD LOC IV and shall be keyed alike according to College master key number. No exceptions allowed.
- D. Finish: Powder coated WHITE to match ceiling tiles.

## 2.4 ACCESSORIES

- A. Extension Pipes and Couplers:
  - 1. Model, Description: In conjunction with ceiling equipment box, use Premier Mount #PWH-10 as cable pathway and mounting extension and mate between ceiling box and universal mount. To be white in color to match with other mount components.
  - 2. In locations where no ceiling equipment box is used or no drop ceiling grid occurs, use adjustable extension mount and pole to mate to above ceiling Uni-strut structure. Use Premier Mount #AST adjusting length so end of pole and universal projector mount extend below ceiling by 8"-12".
  - 3. As required to accommodate cabling to be passed through the box, pole and mount ultimately to the projector, a fish-mouth 1-1/2" NPT coupler shall be included. This can

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be part of included within the static or adjustable extension pole. Product to be Premier Mount #MSCC or appropriate model as required.

4. In the Career Training room, use I-Beam clamp mount #PP-ITC48C from Premier Mounts.
5. In the Career Training room, use locking pole mounted medium sized equipment box #GB-MBX220 from Premier Mounts.
6. In the Career Training room, use the 24" to 46" adjustable pole #APP-2446 from Premier Mounts for the ceiling projector.

B. Accessories:

1. Include ceiling guy-wire attachment for four places per manufacturer instructions and project / Architect details. Use Premier Mounts #QLCS or approved equivalent using Uni-Strut members and pipe-clamp attachments from McMaster Carr.

### **PART 3 EXECUTION**

#### **3.1 EXAMINATION**

- A. Verification of Conditions: Verify that conditions of substrates previously installed under other sections or contracts are acceptable for product installation in accordance with manufacturer=s instructions prior to universal projector mount installation.
1. Inform Consultant of unacceptable conditions immediately upon discovery.
  2. Proceed with installation only after unacceptable conditions have been remedied.

#### **3.2 PREPARATION**

- A. Verify that mounting surface is capable of supporting a static load of four times the combined weight of the projector and the mount.
- B. Remove projector mount assembly contents from carton and verify that there are no damaged or missing parts.
- C. Surface Preparation: Prepare surface in accordance with manufacturer=s written recommendations.

#### **3.3 INSTALLATION**

- A. Coordinate installation of universal projector mount in accordance with construction details, manufacturer's installation instructions and reviewed shop drawings at locations and heights indicated.
- B. Coordinate universal projector mount work with work of other trades for proper time and sequence to avoid construction delays.
- C. Install universal projector mount plumb and level to supporting substrate.
- D. Replace non-secure screws with security screws.
- E. Accurately fit, align, securely fasten and install free from distortion or defects.

#### **3.4 ADJUSTING**

- A. Adjust components and systems for correct function and operation in accordance with manufacturer=s written instructions.



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1. Verify that roll adjusts to plus or minus 20 degrees as designed and to meet project requirements.
2. Verify that pitch adjusts to plus or minus 15 degrees as designed and to meet project requirements.
3. Verify that mount operates with 360 degrees of swivel as designed and to meet project requirements

### **3.5 CLEANING**

- A. Upon completion, remove surplus materials, rubbish, tools and equipment.
- B. Waste Management:
  1. Coordinate recycling of waste materials with section for Construction Waste Management and Disposal.
  2. Collect recyclable waste and dispose of or recycle field generated construction waste created during demolition, construction or final cleaning.
  3. Remove recycling containers and bins from site.

### **3.6 PROTECTION**

- A. Protect installed product from damage during construction.
- B. Repair damage to adjacent materials caused by universal projector mount installation.

**END OF SECTION 27 51 16**

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## **SECTION 27 51 26 ASSISTIVE LISTENING SYSTEMS**

### **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. Work included:
  - 1. Provide assisted listening system as described herein.

#### **1.3 SUBMITTALS**

- A. Submit in accordance with Sections 01 33 00: Submittal and 26 00 00: General Electrical Requirements.

#### **1.4 QUALITY ASSURANCE**

- A. The quantity of wireless headsets on-site shall satisfy the ADA requirement of 4% of the occupancy in the largest conference room and/or assembly area. Refer to architectural sheets for occupancy loads/types.

#### **1.5 WARRANTY**

- A. The entire system shall be of one manufacturer and shall carry a 2-year (minimum) warranty. The system shall be as manufactured by Williams Sound Corp. or engineer approved equal.

### **PART 2 PRODUCTS**

#### **2.1 ASSISTED LISTENING SYSTEMS**

- A. Provide and install complete, ADA compliant Assisted Listening Systems as follows:
  - 1. The campus shall have (as a minimum):
    - a. (1) Portable system consisting of a hard suitcase-style carrying case and containing:
      - 1) (1) Battery operated, belt (clip) FM transmitter unit with lapel microphone.
      - 2) (4) Battery operated, belt (clip) receivers with built in ambient (environmental) microphone and single (bud-style) earphone.
    - b. The portable systems shall be located in the Administration Office available for check out. Refer to Architectural specifications for signage requirements at conference rooms and assembly areas.

### **PART 3 EXECUTION**

#### **3.1 COMMISSIONING**

- A. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, and servicing of the system. Provide a minimum of 2 hours of training. Operators Manuals and Users Guides shall be provided at the time of this training.

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- B. Schedule training with Owner through the Architect, with at least seven days advance notice.

**END OF SECTION 27 51 26**

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## **SECTION 27 53 13 - CLOCK SYSTEM**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. The general conditions, Division 1, and Basic Electrical Requirements (Section 26 05 00) are part of this section and the contract for this work and apply to this section as fully as if repeated herein.
- B. Reference to other sections: The applicable requirements from other Division 26 sections required for a complete and operational system shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Wireless secondary indicating clocks.
- B. Scope includes but is not limited to:
  - 1. Provide (1) 5 watt transmitter, shelf and associated roof mounted antennas.
  - 2. Provide (1) classroom clock in each classroom and associated 120V clock outlet and branch circuit as noted on the E and T drawings.

#### **1.3 DEFINITIONS**

- A. NIST: The National Institute of Science and Technology.
- B. UTC: Universal time coordinated. The precisely measured time at zero degrees longitude: a worldwide standard for time synchronization.

#### **1.4 CODES, STANDARDS AND REFERENCES**

- A. ANSI/NFPA 70: National Electrical Code (NEC), with California Amendments
- B. (CEC).
- C. ANSI/IEEE Std. 1100-1999: Recommended Practice for Powering and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems
- D. ASCE/SIE 7: Minimum Design Loads for Buildings and other Structures.

#### **1.5 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Master clock and housing 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."

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## 1.6 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes (including available colors) for each product indicated and describe features and operating sequences, both automatic and manual, for the following:
  - 1. Wireless Indicating clocks.
  - 2. Accessory components.
- B. Operation and Maintenance Data: For clock and program control to include in emergency, operation, and maintenance manuals.

## 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC , by a independent qualified approved testing agency, and markeÖ for intended location and application.
- B. Comply with CEC.
- C. Installers: Shall be factory authorized and approved to installed specified equipment in San Diego County. Factory authorization shall be provided prior to start of Project.

## PART 2 - PRODUCTS

### 2.1 MASTER AND SECONDARY CLOCK SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by the following to match existing:
  - 1. Innovation Wireless

### 2.2 SECONDARY INDICATING CLOCKS

- A. Wireless Digital Clocks:
  - 1. Surface mounted 4-digit, 7-segment dimmable white LED display. Innovation Wireless #632402
  - 2. 120VAC powered with corÖ and plug.
  - 3. Clocks shall automatically update from the transmitter at regular intervals every day. System shall automatically adjust for Daylight Saving Time.
  - 4. Clocks shall keep operating in synchronized mode if the GPS signal is lost due to GPS failure. Once signal is re-acquired, clocks shall resume GPS time synchronization.
  - 5. Clocks shall keep operating as quartz based clocks for a minimum of 8 hours if there is a transmitter malfunction.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Provide one clock per classroom or as noted per the E and T drawings.
- B. Mount system components with fastening methods and devices designed to resist the seismic forces indicated.

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### **3.2 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
  - 1. Perform operational-system tests to verify compliance with the Specifications and make adjustments to bring system into compliance. Include operation of all modes of clock correction and all programming and manually programmed signal and relay operating functions.
  - 2. Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
- B. Clock system will be considered defective if it does not pass tests and inspections.

### **3.3 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train District's maintenance personnel to adjust, operate, and maintain clock-and-program-control system components.

**END OF SECTION 27 53 13**

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## **SECTION 280500 – SECURITY SYSTEM GENERAL REQUIREMENTS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Standard Guidelines referenced in Division 01 Summary Section, apply to this Section.

#### **1.2 BASIC DEFINITIONS**

- A. Mira Costa College shall be hereinafter referred to in this document as Owner and the respondent shall be referred to as Contractor. The term Owner includes direct employees and other appointed Owner agents such as Architects or consultants. These agents may be requested by Owner to represent Owner in undertaking certain project tasks.
- B. "Days": As used in the specifications, the word "days" means calendar days including weekend days.
- C. "Provide": As used in the plans and specifications, the word "provide" means to furnish, install, connect, program, test, commission and warranty the subject material or services.
- D. Specified Items – Substitutions
  - 1. "No Acceptable Equal": The exact make and model number identified in this Specification shall be provided without exception. Where compatibility with existing systems is specified, and where a specific make or model number is not identified, the Contractor shall provide equipment which is compatible with, and equivalent to, existing equipment of the same description and type, and serving the same purpose.
  - 2. "Or Equal": An item may be substituted for the specified item provided that in every technical and aesthetic sense, the substituted item provides the same or better capability than the specified item, and is fully compatible with the new or existing systems specified. For expansion of existing systems, the item shall also be approved and fully supported by the existing system manufacturer. The Owner shall be the sole authority to determine the equality of substituted products with specified items.
  - 3. "Aesthetics", or "Aesthetic Considerations": If aesthetic considerations are involved in either the 'or equal' or 'approved equal' category, this shall be a consideration in approving or disapproving the proposed substitute. If the proposed substitute is aesthetically unacceptable to the Owner, then the specified, or another technically equal item, shall be provided.
- E. "Beneficial Use": Each component of a system is not considered available for beneficial use until and unless all components and conditions have been fulfilled to make the system fully operational.

#### **1.3 LOCATION AND ACCESS TO PROJECT**

- A. Project is located at MiraCosta Building 900: 3333 Manchester Avenue, Cardiff, CA 92007
- B. Any access using normal highway routing to the facility is acceptable.

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- C. Permission for access to this campus or facility may be revoked for any and all persons who violate facility traffic regulations including speed limits, parking restrictions and directions of the responsible Owner or project personnel. Contractor's personnel, operating forces, and delivery personnel shall be made aware of and shall comply at all times with the regulations and the direction of responsible Owner and project personnel.

#### **1.4 SITE ACCESS CONTROL**

- A. The Contractor shall obtain rules and regulations from the Owner's Project Manager and shall train construction and delivery personnel on their requirements. Contractor shall consistently remain in contact with the Owner for revisions to project policy, and shall be held fully responsible for monitoring and ensuring Contractor and Subcontractor compliance to Mira Costa College Access Control rules and regulations as directed by the Owner.
- B. Contractor's personnel, operating forces, and delivery personnel shall strictly follow all rules and regulations concerning Access Control at the site, including but not limited to those relating to credentialing, background checks, and access to restricted and secure areas, parking, the handling of Access Control information, and the use of the facility.

#### **1.5 DESCRIPTION**

- A. General Description: This specification section covers general requirements for the furnishing, installation and testing of a complete expansion to the Owner' electronic access control and Intrusion detection system.
- B. Furnish and install Electric Access Control System (EACS) software programming, hardware devices, mounting brackets, power supplies, switches, equipment cabinets, controls, consoles, and other components of the system as shown and specified.
- C. Furnish and install EIDS Electronic Intrusion Detection System (EIDS) software programming, hardware devices, power supplies, and other components of the system as shown and specified.

#### **1.6 SCOPE OF WORK**

- A. Systems: Provide an Electronic Access Control System (EACS) and Electric Intrusion Detection System (EIDS) with acceptable engineering and installation practices as described herein.
  - 1. See drawings for existing doors to be reused. General Contractor (GC) to patch and paint existing doors. Security contractor to coordinate removal of existing non-electrified hardware with GC for patching of doors if required prior to painting. Security contractor to provide, install and terminate all new electrified door hardware. Reference section 28 13 00 and division 08 for door hardware types.
- B. Areas of work include, but are not limited to:
  - 1. Shop Engineering and Documentation
  - 2. Wiring and Installation Diagrams
  - 3. Submittals
  - 4. Coordination
  - 5. System Installation
  - 6. System Integration



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7. Training
8. Start-up Testing
9. Commissioning
10. Close out As-Build documentation
11. Warranty

## 1.7 BID RESPONSE

### A. Bidders Responsibility

1. Contractor is responsible for verifying actual conditions by visiting the site, reviewing the Specifications and drawings, and to advise the Owner in writing of any conditions which may adversely affect the work. If any necessary exceptions are discovered, Contractor shall immediately notify the Owner for resolution prior to any change in the design or the scope, and any resultant claim for additional compensation.
2. The Bid Response must fulfill the intent of the Drawings and Specifications to the satisfaction of the Owner to qualify as an acceptable Bid Response.

### B. Substitutions

1. Catalog and/or model numbers for Owner approved equipment and systems are included as a part of these specifications.
2. Any substitution proposed by Contractor for catalog numbers and brands or trade names noted or specified herein shall be solely at the Contractors risk. The Owner maintains sole authority to hold a review of substitutions, and sole authority to approve or disapprove of substitutions for any reason.
3. The Owner's acceptance of substitutions shall not relieve Contractor from complying with the requirements of the drawings and Specifications. Contractor shall be responsible, at Contractor's sole expense, for any changes resulting from Contractor's substitutions that affect other parts of Contractor's own work or the work of others.

### C. Technical Bid Submission: At bid submission, submit one (1) copy of the following

1. An equipment list with names of Manufacturers of primary systems (EACS & EIDS) including model numbers and technical information on equipment proposed.
2. A letter from the manufacturer(s) stating that the system Contractor is an authorized distributor or installer of the proposed primary systems (EACS & EIDS).
3. Indicate complete and total compliance with the provisions of these Specifications by letter or by submittal of the bid response forms, signed by an officer of the corporation, or a principal if other ownership currently exists. If there are exceptions to the specifications, submit a statement listing every technical and operational parameter wherein the submitted equipment or system may vary from that which was originally specified. If the submitter fails to list a particular variance and his submittal is accepted, but is subsequently deemed to be unsatisfactory because of the unlisted variance, the submitter must replace or modify such equipment at once and without cost to the Owner.
4. Failure of Contractor to submit the above information shall be considered non-responsive to the bid requirements and sufficient cause for bid rejection.

### D. Examination of Site and Verification of Existing Conditions

1. Contractor shall have visited the site and familiarized himself with existing conditions prior to submitting his bid and shall be prepared to carry out the work within the existing limitations. Failure or neglect to do so shall not relieve Contractor of his responsibilities nor entitle him to additional compensation for work overlooked and not included in his bid.

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2. Existing structures and utilities shown on the contract drawings are obtained from project drawings and exploratory field examination. Contractor shall verify existing conditions and required dimensions, including those shown on the drawings, by measurement at the job site. Contractor shall notify the Owner of exceptions before proceeding with the work.
  3. Contractor shall confirm the availability of the proper power source for each piece of specified equipment, through site visits and drawings as necessary. Where proper power does not exist, Contractor shall identify this situation to the Owner for guidance. Should the Owner direct Contractor to provide the necessary power, it shall be provided using equipment and methods authorized by the Owner.
- E. Data Accuracy: Absolute accuracy of information regarding existing conditions cannot be guaranteed. The Drawings and Specifications are for the assistance and guidance of Contractor and exact locations, distances, and elevations will be governed by actual field conditions. Where variations from the bid documents are required, such variations shall be approved by the Owner.

## 1.8 QUALIFICATIONS

### A. General

1. The approved Contractor shall be responsible for satisfactory operation of the system and its certification.
2. Approval of the Owner is required of products or services of the proposed manufacturer, suppliers and installers and will be based upon conformance to the specifications.

### B. Manufacturer Qualifications

1. System components shall be furnished by manufacturers of established reputation and experience who shall have produced similar equipment and who shall be able to refer to similar installations rendering satisfactory service.
2. The manufacturer's products shall have been in satisfactory operation on at least three similar installations for not less than three years. Contractor shall submit a list of similar installations.
3. Components including, but not limited to, card access controllers, cameras, intercoms, computers, and power supplies shall have been tested and listed by Underwriters Laboratories, Inc., Factory Mutual Systems, or other approved independent testing laboratory.
4. Components installed within a common enclosure shall be approved by an agency recognized by the local city Department of Building and Safety as an assembly.

### C. Contractor Qualifications

1. Hold current legally required California State Contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated. Contractor shall submit copies of licenses to Owner prior to the start of work.
  - a. C-10 license required for all EACS and IDS installation, termination and testing of systems.
  - b. C-28 license required for all electrified door hardware installation and termination and testing.
2. Hold current legally required state registrations required to meet local requirements for submittal drawings
3. Must provide letter documenting current status as Lenel/S2 certified dealer and installer. If Company is Greenfield exempt, Company shall list the Lenel/S2 Value Added Reseller (VAR) that will supply, install, program and warranty the Lenel/S2 system. Project

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submittals must include copies of Lenel/S2 field technician certificates for all individuals that are working on campus EACS.

4. Indicate complete and total compliance with the provisions of these Specifications by letter or by submittal of the bid response forms, signed by an officer of the corporation, or a principal if other ownership exists. In addition, the letter or forms shall include a complete listing of exceptions, if any.

## **1.9 PHASING PLAN**

- A. The work shall be performed in phases.
  1. Each phase of work shall include, but not be limited to the provision of applicable conduit, power, equipment, programming, and documentation to provide a complete, operational system, as described herein.
  2. Coordinate work phasing with the Owner
  3. Within 14 days after award of the project, submit a preliminary phasing plan to the Owner for review. The Shop Drawings shall reflect the process of the phasing plan.
- B. Phasing Plan: The proposed phasing plan should address the scope with the following approach:
  1. Install or coordinate with the Owner on the installation of the required network connectivity.
  2. Install, power, and test the control equipment, including but not limited to video recorders, EACS controllers, computer workstations, and application software.
  3. Install conduit, cable, and new devices. Connect to controls, and test.
  4. Install conduit, cable, and devices which replace existing devices. Connect to controls, and test.
  5. Program, configure, test and commission the system as required by the Owner and these specifications.
- C. Modifications to the Phasing plan may be submitted by the Contractor, after the Shop Drawings and Equipment Submittals have been reviewed and accepted for installation. The Contractors' modified phasing plan shall be based upon Contractor's actual proposed equipment, project schedule and installation planning. The proposed phasing plan shall be designed to achieve the same goals as the phasing plan contained herein, including but not limited to, the successful upgrade of existing Access Control systems while maintaining full Access Control at the facility. The Contractors' plan must be accepted by the Owner prior to any demolition or installation of equipment and cable. The Owner reserves the right to modify the proposed plan, or any part thereof.

## **1.10 GENERAL CONDITIONS**

- A. Contract Compliance: Provide the Systems and Services in accordance with the conditions and system descriptions as described in Part 1 of each specification section. Provide specified or Owner approved equivalent alternate products as described in Part 2 of each specification section. Utilize specified procedures and practices as described in Part 3 of each specification section.
- B. Codes: Furnish material and workmanship for this work in conformance with applicable legal and code requirements.

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- C. Inclusive Work: Provide sufficient time, material, and manpower to verify, revise or refine the Bid Drawings as necessary to develop fully engineered Shop Drawings as required by the General Requirements, and in order for this work to realize complete, stable and safe operation.

## 1.11 RELATED WORK

- A. General
  - 1. Observe interface procedures to related work.
  - 2. Coordinate with the Owner on aspects of aesthetic interface.
  - 3. Coordination: Coordinate this work with related work by other contractors.
  - 4. Coordinate with existing construction, equipment, and field devices.
  - 5. Equipment provided under this project shall be installed in a manner consistent with architectural, operational, service and maintenance considerations.
  - 6. "Coordinate" related work not specifically mentioned below.
- B. Owner's General Provisions and Work Contract
- C. Division 01, General Requirements: Coordinate this work with applicable sections of the Owner's General Requirements and General Provisions.
- D. Division 08, Openings: Coordinate this work with applicable sections of Division 08, Openings, including but not limited to the following.
  - 1. Schedules for Openings: Coordinate Access Control requirements with door, frame, and hardware schedules.
  - 2. Section 08 70 00 – Hardware, and Mira Costa College guidelines for door hardware.
  - 3. Door hardware, door and frame modifications shall be provided by the Security Contractor. Security Contractor shall coordinate with the Owner on requirements and interfaces with Access Control hardware.
  - 4. Access Doors: Coordinate with the Owner for the provision of access doors where needed to gain access to wiring, boxes, panels and enclosures in walls or ceilings.
- E. Finishes: Coordinate this work with applicable Owner requirements for Finishes, including but not limited to the following.
  - 1. Painting/Patching: Provide painting, patching and repair services to match existing conditions.
  - 2. Painting of walls shall be from corner of nearest wall across repair area to nearest wall on opposite side of repair area.
- F. Division 14, Conveying Equipment: Coordinate this work with applicable Owner requirements of, Conveying Equipment, including but not limited to the following.
  - 1. Owner's requirements for Elevator Equipment and Controls.
  - 2. Elevator work shall be provided by the Contractor.
  - 3. Contractor shall coordinate with the Owner on requirements and interfaces with elevator equipment.
- G. Division 26, Electrical
  - 1. Coordinate this work with applicable sections of Division 26, Electrical, including but not limited to the following:

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- a. Electrical power distribution sources for existing buildings shall be by the Owner unless otherwise noted. Contractor shall coordinate with the Owner to identify and verify 120-volt power service requirements with the first shop drawing submittal.
- b. Conduit, boxes, and rough-in material shall be provided and installed by the Electrical Contractor, unless otherwise noted.
- c. Specialty boxes shall be provided by the Security Contractor and installed by the Security Contractor, unless otherwise noted.

#### H. Division 27, Communications

1. General: Coordinate this work with applicable sections of Division 27, Communications, including but not limited to structured cabling, fiber optic cabling, telephone, and data communications requirements.
2. Contractor shall coordinate with the Owner to identify and verify shared cable/pathway, LAN ports, and bandwidth requirements at the time of the first shop drawing submittal.

#### I. Division 28, Electronic Safety, and Access Control

1. Section 28 05 00 – Security System General Requirements
  - a. Provide equipment and services required by related Sections pursuant to the requirements of Section 28 05 00, Security System General Requirements.
2. Section 28 05 53 – Identification for Electronic Safety and Security
  - a. Provide equipment and services required by related Sections pursuant to the requirements of Section 28 05 53, Identification for Electronic Safety, and Security.
3. Section 28 07 00 – Security System Integration
  - a. Provide equipment and services required by related Sections pursuant to the requirements of Section 28 07 00, Access Control System Integration.
4. Section 28 08 00 – Testing and Commissioning
  - a. Provide equipment and services required by related Sections pursuant to the requirements of Section 28 08 00, Testing and Commissioning.
5. Section 28 13 00 - Electronic Access Control and Intrusion Detection Systems
  - a. Provide equipment and services required by Section 28 13 00, Alarm, and Access Control System, pursuant to the requirements of this section.

- J. Coordinate related work with door hardware including but not limited to automatic motorized gates and door openings, power assisted door opening and powered panic hardware.

### 1.12 PRECEDENCE

- A. If any statement in this or any other Division 28 specification is in conflict with any provision of the General Terms and Conditions of the contract, the provision stated in the General Terms and Conditions shall take precedence. Any questions that result from such potential conflict, which require additional interpretation and guidance shall be immediately brought to the Owner's attention.
- B. Obtain, read and comply with Division 26, Electrical and applicable sub-sections of the contract specifications. Where a discrepancy may exist between any applicable Division 26 sub-sections and directions as contained herein, this section shall govern.
- C. Architectural drawings shall have precedence over other drawings in regard to dimensions and location.

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### 1.13 APPLICABLE PUBLICATIONS

- A. The edition of the appropriate code or standard at the time of permitting shall govern all applications.
- B. Standards: Perform the work in accordance with the following standards:
  - 1. UL Underwriters Laboratories, Inc., UL 294, UL 1076, ULC
  - 2. EIA Electrical Industries Association.
  - 3. NTSC National Television Standards Committee.
  - 4. NEMA National Electrical Manufacturers Association.
  - 5. NECA National Electrical Contractors Association, Standards of Installation.
  - 6. NFPA National Fire Protection Association 101 Life Safety Code
  - 7. CCR Title 24 California Building Code
  - 8. CCR Title 24 California Electric Code
  - 9. ADA Americans With Disabilities Act
  - 10. FCC Part 15, Part 68
  - 11. IEEE RS 170 variable standard NTSC (color camera broadcast)
- C. Where more than one code or regulation is applicable, the more stringent shall apply.
- D. Cable installation, identification and termination shall be performed in accordance with manufacturer's installation manuals in addition to the above applicable codes.
- E. In the absence of manufacturer's recommendations on conductor applications, the Contractor shall ensure that the cable selected meets all technical requirements of the location of its installation, and of the equipment to be installed.

### 1.14 SHOP DRAWING & EQUIPMENT SUBMITTAL

- A. General: Bid documents, including drawings, details and specifications are considered conceptual in nature, and provide direction on products and project requirements. Contractor is given a choice of methods that may be incorporated into the system. These choices may affect the overall design, configuration, and installation of the proposed system.
- B. Contractor Responsibility: Prepare and submit shop drawings, rendered in the latest AutoCad or Revit format, which show details of all work to insure proper installation of the work using those materials and equipment specified or allowed under the approved plans and specifications. A complete Shop Drawing submittal package shall consist of Drawings, Equipment Data Sheet Submittals, and an Acceptance Testing Plan.
- C. Completeness: The Equipment Submittals, Acceptance Testing Plan and the Shop Drawings should be submitted as a complete and contiguous package. Partial or unmarked submittals will not be accepted for review.
- D. Scheduling: A schedule of shop drawing submissions shall be submitted for the Owner's review on a form acceptable to the Owner within ten (10) days after award of the Contract. The schedule of shop drawing submissions shall include as a minimum, but not limited to the requirements stated herein.
- E. Requirements: Provide the following information complete, and in the manner described herein:



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1. Hardware, Application Software, and Network Requirements: A system description including analysis and calculations used in sizing equipment required by the security systems. The description shall show how the equipment will operate as a system to meet the performance requirements of the systems. The following information shall be supplied as a minimum:
  - a. Server(s) processor(s), disk space and memory size and/or expansion of existing
  - b. Workstation(s) processor(s), disk space and memory size
  - c. Description of site (field) control equipment (Controllers/Field Panels, NVR's, Modules) and their configuration
  - d. Operating System(s) Software, where software is provided or upgraded
  - e. Application Software, with Optional and Custom Software Modules supplied in this project
  - f. Integration Schemes: Proposed connectivity, software, development requirements, and SDK information, for inter-system communication.
  - g. Network bandwidth and reliability requirements
  - h. Number and location of LAN ports required
  - i. Other specific network requirements, preferences, and constraints
  - j. Backup/archive system size and configuration
  - k. Start-up operations
  - l. System power requirements and Uninterruptible Power Supply (UPS) sizing
  - m. Device/component environmental requirements (cooling and or heating parameters)
2. Shop Drawings: Shop Drawings shall be numbered consecutively and shall accurately and distinctly present the following information:
  - a. Title Sheet:
  - b. Floor Plans: Showing devices, pull boxes, cabinets, conduits, and conductors in their proposed locations with device numbering scheme.
  - c. Riser Diagram: Showing all conduit relationships between devices shown on the Floor Plans. Show all power sources.
  - d. Single-Line/Block Diagrams: Show signal relationships of controls and devices within the system.
  - e. Custom Assembly Diagrams: For each custom assembly, such as Access Control Terminal Cabinets, receptacle assemblies, or door control panels, provide an assembly drawing illustrating the appearance of the assembled device. Include dimensions, assembly components, and functional attributes (momentary or alternate action switch, lens color, panel finish)
  - f. Component Connection Diagrams:
    - 1) For each equipment component, such as a computer, video switcher, camera or video recorder, show the rear elevation of the device and all connectors/terminations as a pictorial.
    - 2) Show the wire designations on connectors. Typical wiring detail where multiple of same device is provided.
    - 3) Show a schedule of the wire colors connected to the pins on each device connector.
  - g. Equipment Wiring Diagrams:
    - 1) Show a pictorial illustration of each equipment enclosure and/or terminal cabinet, including terminals, components, and wiring devices.
    - 2) Show the device nomenclature exactly as shown on the single line diagrams.
    - 3) Terminations: Show every termination and terminating cable, with applicable cable and wire numbers matching the single line diagrams.
      - a) Every termination in the system must be documented.
      - b) Termination information may be rendered as a wiring list(s), if properly coordinated with, and referenced to, typical component and single-line

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diagrams. Otherwise, the Shop Drawings shall show a pictorial of every component in the system, with its terminations.

- 4) Show wire colors for each terminal.
  - 5) For each wire exiting the enclosure, show the destination of the wire by floor, room number and the drawing number of the panel where the wire terminates.
- h. Provide working dimensions and erection dimensions.
  - i. Arrangements and sectional views
  - j. Necessary details, including complete information for making connections between work under this Contract, existing work, and work under other Contracts.
  - k. Stock or standard drawings will not be accepted for review unless full identification and supplementary information is shown thereon in ink or typewritten form.
  - l. Duplicate of design drawings may be used where each sheet is modified to reflect contractor coordination, specific requirements of the project and multidiscipline conditions.
  - m. Each Drawing or page shall include:
    - 1) Project name, Project Number, and descriptions.
    - 2) Submittal date and space for revision dates.
    - 3) Identification of equipment, product, or material.
    - 4) Name of Contractor and Subcontractor.
    - 5) Name of Supplier and Manufacturer.
    - 6) Relation to adjacent structure of material.
    - 7) Physical dimensions, clearly identified.
    - 8) ASTM and Specifications references.
    - 9) Identification of deviations from the Contract Documents.
    - 10) Contractor's stamp, initialed or signed, dated and certifying to review of submittal, certification of field measurements and compliance with Contract.
    - 11) Location at which the equipment or materials are to be installed. Location shall mean both physical location and location relative to other connected or attached material.
3. Equipment Submittals
- a. Provide a Title Page, with project name, Contractors name and address, contact information, date of submission, and submission revision number.
  - b. Provide a Parts List, for proposed equipment, materials, components and devices, listing the following information for each line item:
    - 1) The system type
    - 2) Model number
    - 3) Specification sheet page reference
  - c. Provide Manufacturers Specification Sheet with descriptive information for equipment, materials, components, and devices. Number each page, to correspond with the Parts List.
  - d. Clearly delineate (with highlighter, arrow, or underline) on each specification sheet, specific model numbers, options and configurations being proposed for this project.
  - e. Indicate kinds of materials and finishes for equipment where more than one option is presented.
4. Acceptance Testing Plan



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- a. Submit a written document detailing the test procedures to be followed in evaluating and proving the installed system(s).
  - b. Provide a sample of the test forms to be used for each system and for each component of each system.
  - c. Include all tests required by the equipment manufacturer and by this Specification.
5. Spare Parts List: Submit a list of recommended spare parts. Spare parts shall comprise a minimum of 5% or minimum of 2 each of field devices, device termination boards and a minimum of 1 system controller boards.
6. Training Program
  - a. Submit a training program 10 working days prior to scheduled training to be followed in training key employees in the operation and maintenance of the installed system at the project site. The proposed training program shall be designed to provide a level of basic competence with the system for selected personnel. These selected personnel shall then be expected to train other personnel as required, utilizing the training that they have been given and the body of training documentation provided by Contractor. This plan shall comply with the requirements stated in the "Training" section, of these Specifications, all stated hours of which shall be considered to be classroom hours.
  - b. Submit a curriculum to account for, and relate, each subject to actual training time. All required hours shall be accounted for in this curriculum.
  - c. The training plan shall cover the overall system, each individual system, each subsystem, and each component. The plan shall also cover procedures for database management, normal operations, and failure modes with response procedures for each failure. Each procedural item must be applied to each equipment level.
- F. The Owner will return unchecked any submittal which does not contain complete data on the work and full information on related matters.
- G. Verification: The contractor shall check and acknowledge all shop drawings, and shall place his signature on all shop drawings submitted to the Owner. Contractor's signature shall constitute a representation that all quantities, dimensions, field construction criteria, materials, catalog numbers, performance criteria and similar data have been verified and that, in his opinion, the submittal fully meets the requirements of the Contract Documents.
- H. Timeliness: The Contractor shall schedule, prepare, and submit a complete shop drawing assembly in accordance with a time-table that will allow his suppliers and manufacturers sufficient time to fabricate, manufacture, inspect test and deliver their respective products to the project site in a timely manner so as to not delay the complete performance of the work.
- I. Departure from Contract Requirements: If shop drawings show departures from the Contract requirements, the Contractor shall make specific mention thereof in his letter of transmittal, otherwise review of such submittals shall not constitute review of the departure. Review of the drawings shall constitute review of the specific subject matter for which the drawings were submitted and not of any other structure, materials, equipment, or apparatus shown on the drawings.
- J. Contractor Responsibility: The review of shop drawings will be general and shall not relieve the Contractor of responsibility for the accuracy of such drawings, nor for the proper fitting and construction of the work, nor for the furnishing of materials or work required by the Contract. No construction called for by shop drawings shall be initiated until such drawings have been reviewed and approved.

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- K. Shop Drawing Submittal Review: The procedure in seeking review of the shop drawings shall be as follows:
1. The Contractor shall submit four (4) complete sets of shop drawings with equipment submittals and other descriptive data with one copy of a letter of transmittal to the Owner for review thirty (30) working days after award of the contract. The letter of transmittal shall contain the project name, the Owner's Project Number, the name of the Contractor, the list of drawings submitted including numbers and titles, requests for any review of departures from the contract requirements and any other pertinent information. Drawings submitted for review shall be full-sized drawings, rolled and included with the equipment submittals.
  2. Drawings or descriptive data will be stamped "Reviewed", "Furnish as Corrected", "Revise and Resubmit", "Rejected" or 'Submit Specific Item' and one copy with a Letter of Transmittal will be transmitted to the Contractor with the return of submitted documents.
  3. If a shop drawing or data is stamped "Reviewed" or "Furnish as Corrected", no additional submittal is required for that shop drawing.
  4. If a shop drawing or data is stamped "Revise and Resubmit" or "Rejected", the Contractor shall make the necessary corrections and resubmit the documents as required above. The letter transmitting corrected documents shall indicate that the documents are re-submittals.
  5. If any corrections, other than those noted by the Owner, are made on a shop drawing prior to resubmittal, such changes should be pointed out by the Contractor upon resubmittal.
  6. The Contractor shall revise and resubmit the shop drawing as required, until they are stamped either "Reviewed" or "Furnish as Corrected."
  7. After the Contractor's submittal or resubmittal of shop drawings, the Owner shall be provided with fifteen (15) working days for review. Should the Owner require additional review time above and beyond the stated fifteen (15) working days, the Contractor may ask for a time extension and/or monetary compensation, if they can present valid, factual evidence that actual damages were incurred by the Contractor. The Owner shall determine the amount of the time extension and/or the monetary compensation to be awarded the Contractor.
  8. The Owner will not issue a "Notice to Proceed" until shop drawings are reviewed, unless otherwise approved by the Owner.
- L. The Contractor shall be responsible for extra costs incurred by the Owner caused by the Contractor's failure to comply with the procedure outline above.

#### **1.15 OPERATING AND MAINTENANCE MANUALS: RECORD DOCUMENTS**

- A. Phase One: Notwithstanding requirements specified elsewhere, submit the following labeled as the "Operating and Maintenance Manual" within thirty (30) days after Final Acceptance of the Installation:
1. Record Drawings: Submit two (2) copies of revised versions of drawings as submitted in the "Shop and Field" and "Equipment Wiring Diagrams" Submittals showing actual device locations, conduit routing, wiring and relationships as they were constructed. Include nomenclature showing as-built wire designations and colors. Drawings shall include room numbers coinciding with Owner space planning numbering. Drawings shall be submitted in electronic editable AutoCAD or revit files, in ".dwg" or ".rvt" format, on CD or DVD disks.
  2. Manuals: Submit two (2) copies of each of the following materials in bound manuals, or electronic PDF copies on CD/DVD discs, with labeled dividers:
    - a. A final Bill of Material for each system.
    - b. Equipment Instruction Manuals: Complete, project specific comprehensive instructions for the operation of devices and equipment provided as part of this work.

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- c. Manufacturers Instruction Manuals: Specification sheets, brochures, Operation Manuals, and service sheets published by the manufacturers of the components, devices and equipment provided.
  - d. Include information for testing, repair, troubleshooting, assembly, disassembly, and recommended maintenance intervals.
  - e. Provide a replacement parts list with current prices. Include list of recommended spare parts, tools, and instruments for testing and maintenance purpose.
  - f. Performance, Test and Adjustment Data: Comprehensive documentation of performance verification according to parameters specified herein.
  - g. Warranties: Provide an executed copy of the Warranty Agreement and copies of all manufacturers' Warranty Registration papers as described herein.
- B. Phase Two: Within fourteen (14) days of receipt of engineer reviewed Operating and Maintenance Manual (Phase One), submit three (3) electronic copies in AutoCAD editable dwg. format of the reviewed Record Drawings and three (3) copies of the reviewed Operating and Maintenance Manuals to the Owner, on CD or DVD disks.
- 1. The contractor shall provide to the Owner one (1) copy of new executive and user software, including required graphical maps, on CD-ROM disks.
  - 2. Sufficient information, (detailed schematics of subsystems, assemblies, and subassemblies to component level) clearly presented, shall be included to determine compliance with drawings and specifications.

#### **1.16 CHANGES**

- A. Before proceeding with changes or claims for extras, Contractor shall provide written notice, secure prior written approval from the Owner, and substantiate actual cost of each change or claim.

#### **1.17 NOTIFICATION**

- A. Contractor shall not shut off any existing systems. Contractor shall give the Owner at least 14 calendar day notice of any requirement to shut off or interfere with existing alarm, access control, regulating, computer or other service systems. The Owner will arrange and execute any shutdown. Work such as splicing, where approved, and connections necessary to establish or re-establish any system shall be completed by Contractor in close coordination with the Owner.

#### **1.18 INTERFERENCE WITH THE FACILITY**

- A. Transportation and storage of materials at the facility, work involving the facility, and other matters affecting the habitual use by the Owner of its buildings, shall be conducted so as to cause the least possible interference's, and at times and in a manner acceptable to the Owner. Contractor shall make every effort to deliver equipment per the schedule required by the project.

#### **1.19 WARRANTY**

- A. Furnish and guarantee maintenance, repair and inspection service for the system using factory trained authorized representatives of the manufacturer of the equipment for a period of one year after final acceptance of the installation.

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- B. Third Party Device warranties are transferred from the manufacturer to the contractor, which may then transfer third party warranties to the Owner. Specific third party warranty details, terms and conditions, remedies, and procedures, are either expressly stated on, or packaged with, or accompany such products. The warranty period may vary from product to product. These products include but are not limited to devices that are directly interconnected to the field hardware or computers and are purchased directly from the manufacturer. Examples may include but not be limited to; servers, cameras, video recorders, card readers, and computers.
- C. Purpose
1. The Contractor shall repair any system malfunction or installation deficiency discovered by the Owner during the burn in and warranty period.
  2. The Contractor shall correct any installation deficiencies found against the contract drawings and specifications discovered by the Owner during the warranty period.
- D. The service contract shall cover equipment and software related to this contract, and shall provide for the following parts and services, without additional cost to the Owner:
1. Quarterly Inspection, Preventative Maintenance and Testing of equipment and components
  2. Regular Service, Emergency Service, and Call-Back Service
  3. Labor and Repairs
  4. Equipment and Materials
- E. Response Time: Response time for service calls.
1. Emergency service calls where system is not responding to staff directed commands through the computer systems shall be within 2 hours to the project site.
  2. Emergency service calls where controllers are not reporting shall be within 2 hours to the project site.
  3. Normal service calls for device malfunctions shall be within 24 hours during normal working hours to the site.
- F. Repair Time: Contractor shall stock parts in sufficient quantities such that repair or replacement shall be guaranteed within 12-hours. Temporary replacements within this time period shall be acceptable, provided temporary replacements do not compromise system functionality, and provided permanent replacement is achieved within 72 hours. Contractor may contact owner for use of owner supplied spare parts where delay of system repair will have negative impact on system performance.
- G. Commencement: The warranty begins at the time of issuance of the statement of "Final Acceptance of the Installation" by the Owner.
- H. Transferability: The warranty shall be transferable to any person or persons at the discretion of the Owner.
- I. Transmittal: A copy of this Warranty shall be delivered to, and signed for by the Owner. A copy of the signed Warranty document shall be delivered for review as part of the Final Submittals.
- J. Registration: Register Warranty papers for all equipment and software in the name of the Owner. Furnish reproductions of all equipment Warranty papers to the Owner with the Final Submittals.
- K. Sub-Contracting: Warranty service work may not be sub-contracted except with specific permission and approval by the Owner.

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**L. Resolution of Conflicts**

1. The Owner retains the right to resolve unsatisfactory warranty service performance at any time by declaring the work unsatisfactory, stating specific areas of dissatisfaction in writing.
2. If the Contractor or his approved subcontractor does not resolve such stated areas of dissatisfaction within thirty (30) days, the Owner may appoint any alternative service agency or person to fulfill the terms of the Warranty; the cost of which shall be borne by the contractor. This action may be taken repeatedly until the Owner is satisfied that Warranty service performance is satisfactory. Satisfactory resolution of a malfunction shall be considered adequate when the device, equipment, system, or component which is chronically malfunctioning is brought into compliance with the standards of performance as contained herein and published by the manufacturers of the equipment installed.

**1.20 PERMITS AND INSPECTIONS**

- A. Responsibility: Obtain permits and inspections required for the work. Permit and inspection costs will be borne by the Contractor.
- B. Performance: Perform tests required herein, or as may be reasonably required to demonstrate conformance with the Specifications or with the requirements of any legal authority having jurisdiction.
- C. Review: Obtain approvals from authorities responsible for enforcement of applicable codes and regulations to establish that the work is in compliance with all requirements of reference codes indicated herein and required by the appropriate jurisdiction. Make corrections, changes, or additions as required and deliver certificates of acceptance, operation, and/or compliance with the "Operating and Maintenance Manuals" as described herein.

**1.21 TRAINING**

- A. On-Site Training
  1. General: Present, review and describe equipment and materials to the Owner and Owner's operating personnel and fully demonstrate the operation and maintenance of the systems, equipment and devices specified herein.
  2. Training shall comprise two separate levels of training;
    - a. User Group upon substantial completion of the project
      - 1) User group training shall include a site/building walk through indicating locations of equipment and their usage
      - 2) User group training shall include the operation of workstation capability of system monitoring, command override and report generation.
    - b. Maintenance Group upon completion of the project prior to close out
      - 1) Maintenance group training shall include a site/building walk through indicating locations of equipment and their usage
      - 2) Review of as-build documentation at each controller location
      - 3) Trouble shooting techniques in hardware and software

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3. The training shall cover the overall system, each individual system, each subsystem, and each component. The training shall also cover procedures for database management, normal operations, and failure modes with response procedures for each failure. Each procedural item must be applied to each equipment level.
4. Duration: Provide at least 2 hours of on-site training on each system for each group of designated representatives of the Owner at a location convenient to the Owner.
5. On-site training shall commence as follows:
  - a. EACS: Just prior to completion of the first phase of work which establishes the new EACS control over entry and exit portals.
  - b. EIDS: Just prior to completion of the first phase of work which establishes the new EIDS control over monitored doors and devices.

**B. Off-Site Training**

1. Security Contractor shall provide (10) ten hours of staff training and also provide 3 CEUs of Lenel Global Education Classroom Training for the Owner. Coordinate with Owner as to who will be attending, exact dates and location and specific classes / topics and any other relevant information related to training.

## **1.22 SAFEGUARDS AND PROTECTION**

- A. Barriers: Provide and maintain suitable barriers, guards, fences and signs where necessary to accommodate the safety of others relative to and/or for the protection of this work.
- B. Regulations: Comply with OSHPD (where applicable), OSHA, Federal, State, and local regulations and standards pursuant to this work.
- C. Protection: Protect all materials and equipment to prevent the entry or adhesion of any and all foreign material. If necessary, cover equipment with temporary protective material suitable for this purpose.
- D. Finishing: Check, clean and remove defects, scratches, fingerprints, and smudges if necessary from all equipment and devices immediately prior to Acceptance of the Installation.
- E. Damage: Replace all damaged or defective material or work at no additional cost prior to Final Acceptance.
- F. Documentation: Provide written description of accidents by workers, students and staff of any incident occurring on the project. Report incident in writing to Owner immediately and to the Project Manager for follow up.

## **1.23 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Delivery: Unless otherwise noted, pre-testing or configuration is required by the contractor, deliver materials to the job site in manufacturer's original unopened containers, clearly labeled with the manufacturer's name and equipment model identification number.
- B. Storage and Handling: Store and protect equipment in a manner which will preclude damage.

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#### **1.24 EQUIPMENT COMPATIBILITY REQUIREMENTS**

- A. While individual items of equipment may meet the equipment specifications and in fact meet the system specifications, the total system shall be designed so that the combination of equipment actually employed does not produce any undesirable effects such as signal distortion, noise, transients, or crosstalk interference's when electrically associated with itself or other equipment.

#### **1.25 OWNER'S RIGHT TO USE EQUIPMENT**

- A. The Owner reserves the right to use equipment, material and services provided as part of this work prior to Acceptance of the Work, without incurring additional charges and without commencement of the Warranty period.

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL**

- A. These general criteria shall apply to "Part 2-Products" of all Access Control specifications that are a part of this work.
- B. Product Acceptability: Products sections contain lists of Owner acceptable products. If product substitutions are proposed, they must be made based upon a comparison of equivalence to the product specified. 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.
- C. Manufacturers Specification Reference: Where a specific material, devices equipment or systems are specified directly, the current manufacturers' specification for the same becomes a part of these specifications, as if completely elaborated herein.
- D. Equipment shall be new and the current model of a standard product of a manufacturer of record. A manufacturer of record shall be defined as a company whose main occupation is the manufacture for sale of the items of equipment supplied.
- E. For each item of equipment offered, manufacturer shall maintain:
  - 1. A factory production line.
  - 2. A stock of replacement parts.
  - 3. Engineering drawings, specifications, operating manuals and maintenance manuals.
  - 4. Manufacturer shall have published and distributed descriptive literature and equipment specifications on each item of equipment offered.
- F. Complete System: Auxiliary and incidental equipment necessary for the complete operation and protection of the systems specified herein shall be furnished and installed as if specified in full.

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- G. Similar Devices: Similar devices within a system shall be identical unless specific color variances are required by the Owner or Architect.
- H. Safety: Unless otherwise specified, equipment shall be UL rated individually and listed as an assembly. Electronic equipment shall be of the dead front type, having no exposed live electrical connections, terminals or exposures to hands-on operating surfaces or other exposed surfaces during any power-on condition. Every live electrical connection, terminal or exposure shall be covered with durable, removable insulating material.
- I. Rack Mounting: Rack-mounted electronic equipment shall be specifically designed or modified for standard 19-inch rack mounting unless otherwise noted.
- J. Keying: Key panels identically where provided for similar usage within a system. Coordinate lock types with Owner.
- K. Framing: Floor supported units shall be substantially framed and supported. All bolted connections shall be made with self-locking devices.
- L. Aesthetics: Coordinate console or control panels so that their general appearance is similar. Provide locking panel covers on recessed, semi-recessed and surface mounted control panels not located in equipment rooms. Control panels shall be contained within or mounted to formed and welded aluminum or steel back-boxes. Operating panels shall be recessed within the back-box to a depth sufficient to permit a locking hinge panel cover to close completely without affecting any device within the enclosure.
- M. No contractor proprietary equipment will be permitted without prior approval from the Owner.
- N. Operational Voltage: Devices connected to the fuse or breaker protected electrical system and all auxiliary equipment necessary for the operation of the equipment associated with systems specified herein shall be designed to operate from 105 to 130 volt, 60 Hertz, alternating current service, with stable performance, fully in accordance with these specifications, and shall have integral fuse or circuit breaker protection.
- O. Contractor-fabricated items shall be provided with fuses that indicate when they are blown or defective.
- P. Protection devices shall be located to facilitate replacement, resetting or observation of status without demounting the associated unit and/or de-energizing adjacent equipment.
- Q. Manufacturer's Recommendations: Components and devices shall be operated in accordance with recommendations of the manufacturer and shall contain sufficient permanent identification to facilitate replacement.
- R. Testing Requirements:
  - 1. Equipment, devices, and assemblies shall meet the local city requirements for listing and labeling, which includes UL listing and labeling for manufactured equipment.
  - 2. UL Listing: For devices and assemblies with proper UL listing and labeling, stickers shall be accessible and visible to the Inspectors. Paperwork shall also be available during inspections and shall be provided to the Owner as part of the close out documentation
  - 3. Unlisted Devices and Assemblies: Devices and assemblies without prior listing from testing authorities accepted by the local city, shall be tested by an agency acceptable to the local city prior to inspection, to obtain a listing and label. Documentation on the testing and approval shall be provided to the Owner as part of the close out documentation.

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## 2.2 MISCELLANEOUS PRODUCTS

- A. Cabinets: Hoffman, Rittal or equal, assembled and wired with all components and as indicated on the drawings. Coordinate color, location, and trim with the Owner.
- B. Cable Termination Devices: Screw-Type Barrier Blocks: Marathon/Kulka 601 or Kulka 601-3700 Series, TRW-Cinch, 140, 141 and 142 Series, Phoenix or Buchanan.
- C. Relays: Control relays to be provided by the Contractor shall meet or exceed the following:
  - 1. Provide U.L. listed single pole, double throw (SPDT) type, unless otherwise noted on the drawings, with silver tin oxide contacts.
  - 2. They shall have a contact rating of 250 V AC/DC at 6A on normally open contacts and 2A on normally closed contacts.
  - 3. Control relay bases shall be UL listed, DIN rail mounted style, and shall be compatible with the proposed control relay. They shall have screw terminals for all wiring leads accepting conductors up to size 14 AWG. Relay bases shall have provisions for accepting machine printed labels.
  - 4. Control Relays: Provide relays and bases by Potter & Brumfield, Square D, or equal.
  - 5. Power Relays: Provide American Electronic Components relays or equal by Potter & Brumfield.
- D. Wire and Cable Management: Provide Thomas and Betts Ty-Duct Series of Slotted Wiring Ducts, or equal by Marathon, or Eaton. Wiring duct shall be used within cabinets, enclosures, and terminal boxes for the distribution and management of cables within the enclosures. Provide compatible mounting hardware, end caps, labeling and appurtenances to form a complete wire management system. Comply with manufacturers recommended maximum fill schedules.
- E. Theft Proof Screws
  - 1. Provide Tamperproof security fasteners for the installation of security equipment, cabinets, enclosures and pull boxes in accessible locations. Provide Bryce Fastener PentaPlus series, TP3 style by Tamperproof Screw Company, or equal by Hudson Fastener.
  - 2. Provide six (6) compatible screw drivers and transfer to the Owner prior to final acceptance testing.
- F. Equipment Enclosure
  - 1. Indoor Wall Mount Rack Enclosures
    - a. Provide Atlas WMA Series, or Bud Cabinets Emperor Series, or equal, sectional wall cabinets, with door and mounting rails for standard 19" rack mount equipment.
    - b. Cabinet shall be in three sections: solid door, center section, and rear section. Door and center section shall swing out, permitting service from the rear without disassembling equipment. Center section depth shall be 15", minimum.
    - c. Contractor shall size the height of the cabinet to house applicable equipment, terminals, wire and devices in a neat and workmanlike manner.
  - 2. Indoor Enclosures: Refer to configurations within Specification Section 28 13 00 Electronic Access Control System
  - 3. Outdoor Enclosures: Provide Hoffman DesignLine Type 3R or Type 4 Enclosure, or equivalent, with 10 Gage steel body and door, swing-out rack mount, and extension ring kits as required to house specified equipment. Provide tamper resistant key lock. Contractor shall size the cabinet to house applicable equipment, terminals, wire and devices in a neat and workmanlike manner.

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## **2.3 TEST EQUIPMENT**

- A. The Contractor is responsible for providing test equipment required to test the system in accordance with the parameters specified. Unless otherwise stated, the test equipment shall not be considered part of the system and retain ownership of the equipment. The Contractor shall furnish test equipment of an accuracy better than the parameters to be tested.
- B. The test equipment list shall be furnished as a part of the submittal.
- C. Readiness: Keep test equipment at hand and maintain in calibrated condition at the jobsite as required for routine and performance testing of this work.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Perform this work in accordance with acknowledged industry and professional standards and practices, and the procedures specified herein.
- B. Aesthetics are an important consideration in this installation. Components shall be installed so as to have aesthetically pleasing results per Owner and Architect requirements. Actual locations of visible components shall be coordinated in advance with Owner and Architect.
- C. The Contractor shall insure that installation personnel understand the requirements of this Specification.

### **3.2 COORDINATION**

- A. General
  - 1. This Contract involves functioning systems. Coordination with the Owner is critical. Do not interrupt any functioning system without complying with the requirements of "Notification" section of this specification.
  - 2. Coordinate the work with the Owner and all trades to assure that where this work interfaces to other trades, those interfaces are provided, complete and functional.
  - 3. Meet with the Owner and each trade. Identify devices needed to complete functional operation of this work which are being provided by Owner, General Contractor or another trade, and assure that the work being provided by others will be acceptable.
  - 4. Make sure work by others is scheduled in order that this work can be installed in a timely fashion.
  - 5. Verify dimensions, and work by others which may be necessary to facilitate the work and coordinate with other trades. Assure that related work by others is coordinated with this work.
  - 6. Verify field conditions. Regularly examine construction and the work of others which may affect the work to ensure proper conditions are provided for the equipment and devices before their manufacture, fabrication or installation. Be responsible for the proper fitting of the systems, equipment, materials, and devices provided as part of this work.
- B. Required Resources: Become familiar with the available access and space for equipment and any potential interference requiring coordination. Coordinate with the Owner to assure that

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adequate electrical and HVAC, services are available. Provide the physical space for equipment, and ample access room for installation and maintenance of equipment.

- C. Positioning Members: Provide additional support or positioning members as required for the proper installation and operation of equipment, materials and devices provided as part of this work as approved by the Owner without additional expense.
- D. Interface Devices: Provide items necessary to complete this work in conformance with the Contract Documents or the satisfaction of the Owner without any additional expense.
- E. Equipment shall be mounted with sufficient clearance to meet applicable codes and facilitate observation and testing. Securely hang and/or fasten with appropriate fittings to ensure positive grounding, free of ground loops, throughout the entire system. Units shall be installed parallel and square to building lines.
- F. Installation shall comply with "Codes and Standards" section of this specification. Where more than one code or regulation is applicable, the more stringent shall apply.
- G. Where new equipment is replacing old equipment, Contractor is responsible for removing the old equipment and doing repair work necessary to meet standards determined by Owner.
- H. Install fire stopping for penetrations in slabs and firewalls to meet code at the completion of work and prior to final testing demonstration to Owner.
- I. Project Documentation: Review project documentation. If the Contractor perceives conflict or ambiguity in the contract documents, he shall seek interpretation from the Owner. Failure to do so may result in remedial work.
- J. Project Schedule: Immediately obtain and follow the project schedule established by the Owner. Failure to maintain the schedule may result in a requirement by the Owner to expend extra effort until the project schedule has been achieved.
- K. Schedule Changes: Time is of the essence of this agreement. In the event that it becomes necessary for the Contractor to expend "extra effort" to complete the work according to schedule changes not covered above, the Contractor agrees to cooperate with the Owner in good faith to complete the work according to schedule requirements.
- L. Supervision: Maintain a competent supervisor and supporting technical personnel acceptable to the Owner during the entire installation. A change of supervisor during the project shall not be acceptable without prior written approval from the Owner.
- M. Work and Manpower Rules: Comply with applicable jobsite work and manpower regulations.
- N. Found Conflicts: Continuously make known to the Owner, conflicts discovered which may affect the orderly completion or the specified performance of this work. Cooperate with the Owner and other trades to accommodate such changes as may be necessary to resolve found conflicts.
- O. Coordination Difficulties: Promptly notify the Owner in writing of any difficulties which may prevent proper coordination or timely completion of this work. Failure to do so shall constitute acceptance of construction as suitable, to receive this work, except for defects that may develop in the work of others after its execution.
- P. Environmental: Verify the intended location(s) for equipment is suitable for the equipment. If conditions such as temperature, humidity, dust level or the like require modification, make it

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known to the Owner immediately upon award of the contract. If equipment requires strict environmental conditions (dust limitations, etc.), notify the Owner immediately upon award of the Contract. Failure to notify the Owner of such conditions shall constitute acceptance of the conditions and any later required modifications to the equipment or the environment shall be at the sole cost of the Contractor.

- Q. Extra Effort: The Owner retains the right to require the Contractor to expend whatever extra effort as may be required, in event the Contractor fails to perform satisfactorily at any milestone date, unless such delay is approved in writing by the Owner, or it can be proved by the Contractor that such delay was caused by other contractors, or Owner's intransigence relating to Owner requested changes in the scope of work. Any costs pursuant to such extra effort will be borne solely by the Contractor. If Project Schedule delays are approved, provide the Owner with monthly revisions of the Project Schedule reflecting actual performance vs. the schedule.

### 3.3 SEISMIC PROTECTION

#### A. General

1. Seismic protection criteria: Electrical and mechanical machinery installations in any Seismic Risk Zone of the Uniform Building Code Seismic Risk Map shall be protected from earthquakes.
2. Protection criteria for these zones shall be a Horizontal Force Factor not less than required by code or agency, considered passing through the machinery center of gravity in any horizontal direction.
3. Unless vibration isolation is required to protect machinery against unacceptable structure transmitted noise and/or vibration, machinery shall be protected from earthquakes by rigid structurally sound attachment to the load supporting structure. The number shall be determined by calculations performed by a registered California professional engineer, as verified by the seismic restraint vendor.
4. Use protected spring isolators, or separate seismic restraints, to protect vibration isolation machinery.
5. Seismic snubbers and protected spring isolators shall be seismic protection-rated along three principal axes, proven by independent laboratory testing or analysis, by an independent, licensed structural engineer.

- B. The Contractor shall be responsible for the design of his method for seismic restraint systems, and shall supply all seismic calculations and details to the Owner for review. The Contractor shall supply to the Owner details of the forces exerted by his restraints, anchorages, and other points of attachment.

- C. Electrical and mechanical equipment shall be installed in accordance with the following guidelines:

1. SMACNA Publication: Guidelines for Seismic Restraints of Mechanical Systems
2. California Code of Regulations (CCR), Title 24, Division 22
3. NUSIG – National Uniform Seismic Installation Guidelines

- D. Contractor shall submit shop drawings for the mounting of equipment, fixtures, cabinets, consoles, conduit, and cable support racks (where required). These drawings shall be prepared, stamped, and signed by a Registered California Structural Engineer.

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### **3.4 WORKMANSHIP**

- A. The installation shall be performed in a professional and workmanlike manner.
- B. On a daily basis, clean up and deposit in appropriate containers debris from work performed under the appropriate Specification sections. Stack and organize parts, tools and equipment when not being used.
- C. Preparation, handling, and installation shall be in accordance with the Manufacturer's written instructions and technical data appropriate to the product specified.
- D. Work shall conform to the National Electrical Contractors Association "Standard of Installation" for general installation practice.
- E. At the conclusion of the installation, work areas, including panel boxes, shall be vacuumed and cleaned to remove debris and grease.

### **3.5 EQUIPMENT ENCLOSURES, RACK, AND CONSOLE INSTALLATION**

- A. Construction: Coordinate access openings and wire paths through the cabinets for all desk mounted devices
- B. Compliance: Comply with powering, conduit entry and grounding practices as described herein and as required by code.
- C. Coordination of Access: Coordinate the installation of access covers, hinged panels or pull-out drawers to ensure complete access to terminals and interior components. Access shall be designed such that demounting or de-energizing of equipment is not required to gain access to any equipment.
- D. Enclosures: Fasten removable covers containing any wired component with a continuous hinge along one side with associated wiring secured and dressed to provide an adequate service loop. Appropriate stop locks shall be provided to hold all hinged panels and drawers in a serviceable position.
- E. Service Loop: Provide a wiring service loop allowing relocation of termination to any point within the enclosure.

### **3.6 CUTTING, PAINTING AND PATCHING**

- A. Structural members shall not be drilled, bored or notched in such a manner that shall impair their structural value. Cutting of holes in structural members, if required, shall be done with core drills and only with the specific approval of the Owner for each instance. Provide means to identify rebar in slabs prior to drilling.
- B. Walls and other architectural features that require cutting or repair during the installation process shall be returned to their original condition, including the matching of colors, and finishes to the satisfaction of Owner, and at no additional cost to Owner.

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### 3.7 GROUNDING PROCEDURES

- A. Provide grounding of systems and equipment in accordance with manufacturer's recommendations, local electrical codes, and industry standards.
- B. Signal Ground: Signal ground shall be derived from the one main electrical panel which serves all equipment herein.
- C. Grounding procedures for wire, equipment and devices shall be in strict accordance with manufacturers' recommendations and standard installation practices.
- D. Equipment enclosures of an assembly shall be grounded to the single grounding terminal strip of each assembly.
- E. Multiple Powered System Isolation: Where powered devices of the same system exist in two or more locations and a different signal ground exists in each location, the system's communication signal shall be isolated from signal ground at both source and destination ends via modem, fiber optics or other equivalent method.
- F. Contractor shall eliminate or correct potential ground-loop problems in a manner approved by the Engineer.
- G. Shielding: Shielded cables of this section shall be grounded exclusively to Signal Ground. No shields shall be permitted to carry live currents of any kind. Shields shall be tied to Signal Ground at the signal source end only, unless otherwise noted or required by the manufacturer.

### 3.8 CONDUIT AND WIRE INSTALLATION PRACTICES

- A. Conduit
  - 1. Conduit shall be 1-inch minimum unless noted otherwise on the drawings
  - 2. Wires shall be installed in conduit or in another Owner approved raceway for power and exposed wiring, in areas where mechanical or environmental conditions may damage conductors, and where otherwise specified herein or required by code.
  - 3. Conduit or raceway that is not hidden must have its location and appearance be specifically approved by Owner. If approved, exposed conduit or raceway shall be run in such a fashion as to make it as inconspicuous as possible. Runs should follow existing building lines and should be square wherever possible.
  - 4. Verify conduit has been installed, de-burred and properly joined, routed, and terminated prior to pulling of cables.
  - 5. Apply a chemically inert conduit lubricant to wire and cable prior to pulling. Do not subject wire and cable to tension greater than recommended by the manufacturer
  - 6. Secure wire and cable runs vertically in conduit for continuous distances greater than thirty (30) feet at the vertical run terminations. Non-coaxial cables shall be secured by screw-flange nylon cable ties or similar devices. Symmetrical clamping devices with split, circular, or other wire conforming, non-metallic bushings shall be provided for other cables.
- B. Wiring Without Conduit
  - 1. Wiring may be run in concealed spaces without conduit, in electrical trays, and where otherwise shown on drawings, provided conductors are reasonably protected from mechanical and environmental damage.
  - 2. Any security wiring that is visually exposed must be installed in conduit



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3. Conductors run without conduit shall be approved, UL Listed, rated and labeled for Plenum use.
4. Secure wire and cable with approved supports in accordance with the referenced standards and the Authority Having Jurisdiction.
5. Provide cable supports at a minimum of 4-foot intervals.
6. Equipment and devices shall be installed on approved electrical back-boxes. Do not install equipment and devices directly on walls, ceilings, or structural components without back-boxes.
7. Secure cables to cabinets, junction boxes, pull boxes and outlet boxes with approved cable clamps.
8. Independently support cables. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, mechanical piping, or mechanical ducts).
9. Support cable independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
10. Support cable using cable trays, D-brackets, support straps, support wires or other approved cable supports.
11. Fasten cable supports to building structure and surfaces.
12. In shared electrical trays, open ducts, and other cable runs without conduit, separate and strap Access Control cable so that it is clearly distinguishable from all other cables.
13. Clearly mark security system cables at minimum intervals of every 10-feet. Marking shall be with a permanent, printed label, color-coded tag, or other distinguishing marking. Felt tip pen marking on the cable is not acceptable.

C. New Wiring

1. After installation, and before termination, wiring shall be checked and tested to insure there are no grounds, opens, or shorts on any conductors or shields. In addition, wiring between buildings or underground and all coax cables shall have insulation tested with a megohmmeter and a reading of greater than 20 megohms shall be required to successfully complete the test.
2. Run wires continuously from termination to termination without splices. Splices at junction box locations may be allowed at the discretion of the Owner. Recommendations for splices at these points shall be established with Owner. Contractor shall obtain approval from the Owner before proceeding with splices.
3. If splices are required and approved by Owner, the wire shall be joined with solder, then taped or otherwise protected in an approved manner so as to provide mechanical and electrical integrity. Wire nuts and/or electrical tape connections shall not be acceptable. Final connections shall be made at terminal boards with full tagging, labeling and documentation.
4. Water-resistant protection shall be continuous throughout the cable in parking areas, surface conduit, poles, in-slab pull-boxes, in-slab conduit, and underground conduit and pull-boxes, and in any areas subject to moisture and/or water infiltration:
  - a. Splices/Junctions: Provide water-proof protection of splices and junctions, in surface conduit and boxes, in-slab conduit and pull-boxes, underground conduit, and underground pull-boxes, to prevent the entry of moisture or water into cables, splices, or connections.
  - b. Cable Entries: Provide water-blocking sealants at all conduit entries into pull-boxes, junction boxes, back-boxes, cabinets, etc., to prevent the entry of moisture or water into the conduit and cable system.

- D. Boxes: Provide a box loop for wire and cable routed through pull boxes or controller panels. Cable loops and bends shall not be at a radius less than that recommended by the manufacturer.

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Coordinate pull box size with the Division 26 Contractor as necessary to accommodate this requirement.

- E. Wire Lacing and Dressing: Dress, lace, tie or harness wire and cable vertically, horizontally and at right angles to the enclosure surfaces to prevent mechanical stress on electrical connections as required herein and in accordance with accepted professional practice. No wire or cable shall be supported by a connection point.
- F. Non-Coaxial Connections: Make non-coaxial connections and approved splices within terminal cabinets (except microphone or line level) to screw-type barrier blocks with insulated crimp-type spade lugs. Size all lugs properly to assure high electrical integrity. Connect only one (1) wire per spade lug and not more than two (2) lugs per screw terminal.
- G. Non-Coaxial splicing at device locations to equipment with wire leads shall be made with pre-approved wire Dolphin Connectors.
- H. Shielded Cables: Shielded cables shall be insulated. Do not permit shields to contact conduit, raceway, boxes, terminal cabinets, or equipment enclosures. Tin terminated shield drain wires and insulate with heat shrinkable tubing.
- I. Coaxial Splices: Coaxial splices, if required and approved, shall be on plate mounted dual-barrel type insulated BNC connectors, secured in such a manner that no stress is placed upon the connector.
- J. Unacceptable Conditions: Correct any unacceptable wiring conditions immediately upon discovery, and upon receiving notice to correct.

### 3.9 DATABASE PREPARATION, CHECKING AND ACTIVATION

- A. Contractor to provide forms with completed nomenclature for each identified device no less than 30 days prior to programming.
- B. Programming
  - 1. The Contractor shall be responsible for the full programming of devices and equipment installed in this project. The database shall consist of hardware and function-related information, i.e., system configuration, doors, alarm points, software parameters for system management, graphical maps, intercom interfaces, alarm information – **Global and local I/O**, access levels, automatic opening and locking schedules. A printout of the final database shall be provided to the Owner for review and approval prior to system activation.
  - 2. Programming rights shall be provided the Owner. Contractor shall coordinate with the Owner prior to the completion of installation to set a schedule for access to programming resources.
- C. System activation shall be the responsibility of Contractor.

### 3.10 SOFTWARE UPGRADES

- A. If more recent versions of the operating system or application software are made available to or requested by the Owner prior to system acceptance, these updated versions shall be installed and verified by Contractor.



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- B. Before installing upgrade software, Contractor shall ensure that existing database information is properly "backed-up" prior to any installation action.

### **3.11 START-UP RESPONSIBILITY**

- A. Contractor shall initiate System Operation. Competent start-up personnel shall be provided by Contractor on each consecutive working day until the System is functional and ready to start the acceptance test phase. If in Owner's judgment Contractor is not demonstrating progress in solving any technical problems, Contractor shall supply Manufacturer's factory technical representation and diagnostic equipment at no cost to Owner, until resolution of those defined problems. Where appropriate, Contractor will bring the System on-line in its basic state (i.e., alarm reporting, facility code access control, etc.).
- B. Properly ground each piece of electronic equipment prior to applying power.
- C. Properly ground all shielded wire shields to the appropriate earth ground at the hub end only, not at the remote or device end.
- D. Use a start-up sequence that incrementally brings each portion of the system on-line in a logical order that incorporates checking individual elements before proceeding to subsequent elements until the entire system is operational.

### **3.12 PRELIMINARY, INSPECTION, ACCEPTANCE TESTING, AND COMMISSIONING**

- A. Provide Preliminary Testing, Inspection, Acceptance Testing, Burn-In and Commissioning Performance services for systems and equipment in accordance with Testing and Commissioning, Section 28 08 00.

### **3.13 FINAL PROCEDURES**

- A. Portable Equipment: Furnish portable equipment specified herein to the Owner, along with complete documentation for the materials furnished. Portable equipment shall be presented in the original manufacturer's packing, complete with manufacturer's instructions, manuals and documents. Testing of portable equipment shall have been previously conducted by the Contractor.
- B. Post Acceptance Work: Check, inspect and adjust systems, equipment, devices, and components specified, programming updates, at the Owner's convenience, approximately sixty (60) days after Acceptance of the Installation.

### **3.14 NOTICE OF COMPLETION**

- A. When the performance and acceptance requirements described above, including the Final Acceptance Test, have been satisfactorily completed, the Owner shall issue a Letter of Completion to Contractor indicating the date of such completion. The Notice of Completion shall be recorded by Contractor upon receipt of the Owner completion letter. This date of record shall be the start of the warranty period.

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**END OF SECTION 28 05 00**

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## **SECTION 28 05 13**

### **CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY**

#### **PART 1 - GENERAL**

##### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

##### **1.02 SUMMARY**

- A. Section Includes:
  - 1. Fire alarm wire and cable.
  - 2. Identification products.

##### **1.03 DEFINITIONS**

- A. EMI: Electromagnetic interference.
- B. IDC: Insulation displacement connector.
- C. 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.
- D. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
- E. RCDD: Registered Communications Distribution Designer.

##### **1.04 ADMINISTRATIVE REQUIREMENTS**

- A. Coordinate layout and installation of electronic safety and security cabling with Owner's telecommunications and LAN equipment and service suppliers.
- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

##### **1.05 ACTION SUBMITTALS**

- A. Shop Drawings:
  - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.

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## **1.06 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

## **1.07 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: An NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

## **PART 2 - PRODUCTS**

### **2.01 PERFORMANCE REQUIREMENTS**

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing 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.
- 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.

### **2.02 FIRE ALARM WIRE AND CABLE**

- A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- B. Network Communications: Multi-mode 50/125 OM2 fiber.
- C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG.
  - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
  - 1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
  - 2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.

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3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated.

## **2.03 IDENTIFICATION PRODUCTS**

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION OF HANGERS AND SUPPORTS**

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for installation of supports for cables.

### **3.02 WIRING METHOD**

- A. Install wiring in metal pathways and wireways.
  1. Minimum conduit size shall be 3/4 inch. Control and data-transmission wiring shall not share conduits with other building wiring systems.
  2. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."
- B. Install cable, concealed in accessible ceilings, walls, and floors when possible.

### **3.03 FIRE ALARM WIRING INSTALLATION**

- A. Comply with NECA 1 and NFPA 72.
- B. Wiring Method: Install wiring in metal pathway according to Section 260533 "Raceways and Boxes for Electrical Systems."
  1. Install plenum cable in environmental air spaces, including plenum ceilings.
  2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated pathway system. This system shall not be used for any other wire or cable.
- C. Wiring Method:
  1. Cables and pathways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
  2. Fire-Rated Cables: Use of two-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is not permitted.
  3. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or pathway as signaling line circuits.
  4. Use fiber media for network and audio riser communications.

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- D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- F. Color Coding: Color code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm circuit wiring and another for supervisory circuits. Color code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- G. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

### **3.04 CONNECTIONS**

- A. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

### **3.05 FIRESTOPPING**

- A. Comply with TIA-569-C, "Firestopping" Annex A.
- B. Comply with BICSI TDMM, "Firestopping Systems" Article.

### **3.06 IDENTIFICATION**

- A. Identify system components, wiring, and cabling complying with TIA-606-B.

### **3.07 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:
- D. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

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END OF SECTION

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## **SECTION 280553 - IDENTIFICATION FOR ELECTRONIC SAFETY AND SECURITY**

### **PART 1 - GENERAL**

#### **1.1 DESCRIPTION**

- A. This specification section covers the furnishing and installation of nameplates, labels, wire markers, and other identification components for security systems.
- B. Contractor shall furnish and install identification devices as specified on cables, cabinets, racks, and equipment.

#### **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 Section 28 05 00, Security System General Requirements
- C. In accordance with Section 28 08 00, Security System Testing, and Commissioning
- D. In accordance with Section 09 90 00, Paints and Coatings

#### **1.5 SHOP DRAWINGS & EQUIPMENT SUBMITTALS**

- A. In accordance with Section 28 05 00, Security System General Requirements
- B. Product Data:
  - 1. Submit manufacturer's catalog literature for each product required.
  - 2. Submit identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

#### **1.6 WARRANTY**

- A. In accordance with Section 28 05 00, Security System General Requirements



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## 1.7 REQUIREMENTS FOR IDENTIFICATION AND TAGGING

- A. Cables, wires, wiring forms, terminal blocks, and terminals shall be identified by labels, tags or other permanent markings. The markings shall clearly indicate the function, source, or destination of all cabling, wiring and terminals. The wire marking format contained in the shop drawings shall be utilized for conductors installed under this Specification. Cables and wires shall be identified, utilizing heat-shrink, machine-printed, polyolefin wire markers (Handwritten tags or marker on wiring is not acceptable.)
- B. Should a situation arise where the wire tagging format as shown on the shop drawings cannot be used, a substitute format shall be submitted which complies with the intent to provide documentation that will permit end-to-end tracing of all System wiring.
- C. Terminal points shall be appropriately identified and labeled as shown on shop drawings.
- D. Nameplates – General:
  - 1. Provide laminated, engraved plastic nameplates with 3/8-inch-high letters for all panels, enclosures and cabinets. Attach nameplates to gear with sheet metal screws where applicable. Adhesive mounted nameplates are generally not acceptable.
  - 2. Include nameplate schedule on shop drawing submittals.
  - 3. Install nameplates behind panel door in public areas and on panel face in equipment rooms.
  - 4. Nameplate Color Schedule:
    - a. Fed from Normal Building Power: Black letter on White label
    - b. Fed from Emergency/ Generator Power: White letters on Red label
- E. Panels shall be provided with permanently attached engraved lamacoid labels, as described in Item E, with identifying names and functions. Labels shall be consistent in form, color, and typeface throughout the system and must contain the name of the system or subsystem as part of the label textual information. Handwritten tags or marker type identification is not acceptable.
- F. Equipment/Equipment Racks: Provide an engraved lamacoid label, as described in Item E, on the front of equipment including its designation as assigned and referenced consistently throughout this project.
- G. Enclosures and Cabinets:
  - 1. Provide an engraved lamacoid label, as described in Item E, on the front of wall mounted control enclosures and equipment racks including its designation as assigned and referenced consistently throughout this project.
  - 2. Within each equipment enclosure and/or terminal cabinet, the contractor shall place a Single Line drawing of the system(s) and the respective Equipment/Terminal Cabinet Wiring Diagram in a clear plastic 8" x 11" sleeve permanently attached to the inside cover of the terminal cabinet. Drawings shall include cable and equipment label designations to match the labeling within the cabinet.
  - 3. In each equipment enclosure, the contractor shall place an as-built drawing depicting device locations served by the equipment within the enclosure, with identification that is identical to the wiring tags and with the software description of each point.
  - 4. In each equipment enclosure, the contractor shall place a copy of the EACS System Excel Spreadsheet or equal document depicting device names, MAC addresses and IP addresses as indicated in the EACS system.
- H. Door Openings: For all doors controlled by the EACS system, provide a P-touch label with the door name (as named in the EACS program) on the top of the door edge on the hinge side. P-touch label shall be black lettering on white ¼" tape. Coordinate with Owner for exact location.

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- I. EACS Panel Relays: All relays on EACS panels shall be labeled with P-touch label ¼" tape, black lettering on a white label, identifying the MiraCosta College door number associated with the relay. Architectural door numbers are not acceptable for these labels.
- J. Panic Bar: All panic bars shall be labeled on the inside of the hardware with P-touch label ¼" tape, black lettering on a white label, identifying the location of the power supply feeding the door including room name and room number.
- K. Wire and Cable: Identify wire and cable clearly with permanent labels wrapped around the full circumference within one-inch of each connection. Correlate the number designated on the associated Shop or Field Drawings. Assign wire or cable designations consistently throughout a given system. Each wire or cable shall carry the same labeled designation over its entire run, regardless of intermediate terminations.

## **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. 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. Labeling:
  - 1. Provide intelligible permanent engraved identification function on or adjacent to panel assemblies, power supplies, and cabinets.
  - 2. Provide intelligible permanent label-maker labels for relays, controls, fuses and/or circuit breakers, patching jacks, connectors, receptacles, terminal blocks, indicators, switches, monitors, and servers.
  - 3. Labels shall be machine-printed. Hand-lettered labels shall not be acceptable.
- C. Engraving, labels, decals or other identification on any device, equipment or miscellaneous component shall be coordinated with the associated Field and Shop and Equipment Wiring Drawings.
- D. No proprietary identification on assemblies will be permitted other than the original manufacturer's labels and identification.

### **2.2 MISCELLANEOUS PRODUCTS**

- A. Wire and Cable Labels: Provide Brady Type B-321, dot matrix and thermal transfer printable sleeves, with permanent ink ribbon printing, or Thomas and Betts EZ-W/YHS, or equal. Sleeves shall be constructed of heat shrinkable, high density polyolefin film coated and shall have an ink-receptive top-coating. Labels shall be pre-printed to match the designations shown on the shop drawings, fitted to cables in the field, and heat shrunk to secure their position. Labels should be placed such that they are easily accessed and readable after the device or panel is fully dressed.

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- B. Equipment Labeling: Unless otherwise noted herein, provide Laminated three-layer plastic with engraved black letters on white background color. Minimum thickness shall be 1/8". Letter size shall be 3/8"-1/2" for equipment and controls.
- C. Cabinet/Enclosure Labeling: Unless otherwise noted herein, provide Laminated three-layer plastic with engraved black letters on white background color. Minimum thickness shall be 1/8". Letter size shall be 1/2" minimum.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. In accordance with Section 28 05 00, Security System General Requirements.

#### **3.2 LABEL AND NAMEPLATE INSTALLATION PRACTICES**

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Install labels and nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.
- C. Install identifying devices after completion of painting and finishes.
- D. Nameplate Installation:
  - 1. Install nameplate parallel to equipment lines.
  - 2. Install nameplate for each control equipment enclosure with corrosive-resistant mechanical fasteners.
  - 3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners.
  - 4. Secure nameplate to equipment front using screws.
- E. Wire Marker Installation:
  - 1. Install wire marker for each conductor at each connection.
  - 2. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
  - 3. Install labels at data outlets identifying patch panel and port.

#### **3.3 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.

#### **3.4 FINAL PROCEDURES**

- A. Perform final procedures in accordance with section 28 05 00, Security System General Requirements.

END OF SECTION

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## **SECTION 280700 - SECURITY SYSTEM INTEGRATION**

### **PART 1 - GENERAL**

#### **1.1 DESCRIPTION**

- A. General Description: This specification section covers the provision of mechanisms which will support the exchange and recognition of information and commands between various Security systems at MiraCosta Building 900.
- B. Contractor shall coordinate with providers of systems listed herein to provide equipment, software, and configuration that will support the required functionality and performance.

#### **1.2 QUALIFICATIONS**

- A. Provide the work in accordance with Section 28 05 00, Security System General Requirements.

#### **1.3 GENERAL CONDITIONS**

- A. Provide the work 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. Provide the work in accordance with Section 28 05 00, Security System General Requirements.

#### **1.5 SHOP DRAWINGS & EQUIPMENT SUBMITTAL**

- A. Provide the work in accordance with Section 28 05 00, Security System General Requirements.
- B. In addition to the requirements of Section 28 05 00, provide the following information for each system to be integrated:
  - 1. Describe the integration architecture between systems. Provide a single-line diagram showing relationships between integrated components.
  - 2. If a central integration processing component or user-interface (server, application) is proposed, describe the hardware and application software proposed.
  - 3. A detailed description of how the interface will be accomplished between each system, including proposed connectivity, hardware, software, language, protocols, procedures, and standards.
  - 4. Proposed Software Development Kit (SDK) and Version, where an SDK already exists from the component manufacturer. Provide development and capabilities information on the SDK and its proposed use on this project.
  - 5. Development specification for custom software development, where the interface must be created specifically for the project.

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6. A detailed list, or matrix, of information, commands, and other elements of the interface, delineating exactly what functions will be supported between each system, and how they will work.

## **1.6 OPERATIONS AND MAINTENANCE MANUALS**

- A. Provide the work in accordance with Section 28 05 00, Security Systems General Requirements.

## **1.7 WARRANTY**

- A. Provide the work in accordance with Section 28 05 00, Security Systems General Requirements.

## **1.8 SERVICE AND MAINTENANCE**

- A. Provide the work in accordance with Section 28 05 00, Security Systems General Requirements.

## **1.9 TRAINING**

- A. Provide the work in accordance with Section 28 05 00, Security Systems General Requirements.

## **1.10 EQUIPMENT COMPATIBILITY REQUIREMENTS**

- A. Provide the work in accordance with Section 28 05 00, Security Systems General Requirements.

## **1.11 OWNER'S RIGHT TO USE EQUIPMENT**

- A. Provide the work in accordance with Section 28 05 00, Security Systems General Requirements.

## **1.12 TECHNICAL REQUIREMENTS, ACCESS CONTROL SYSTEM INTEGRATION**

- A. General
  1. The Contractor shall be responsible for providing hardware and software interfaces to achieve the specified system performance described herein and, by reference, realize absolute and seamless compatibility with the related component systems.
  2. The Contractor shall ensure system additions and modifications provided under this scope of work have no negative effect on the individual components and systems, and their core functionality, and no permanent effect beyond that specified or implied by the scope of work.
- B. Purpose
  1. Integration is the process of designing, deploying, and configuring independently operating systems with the ability to request, receive, extract, process, and act upon information from other systems.
  2. Successful system integration must address three fundamental issues:
    - a. Functionality: What information is needed, how it is to be requested and processed, and what functions or activities need to occur upon receipt of the information.

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- b. Connectivity: How systems will be connected together to support the communication of information and commands. (Special interfaces, wiring, networks, databases.)
    - c. Communication: How information will be communicated between systems. (Instruction sets, language, protocols, formats, priority.)
- C. Environment
  - 1. Integration components shall generally comprise special elements of independent subsystems, and shall be located within, or in close proximity to, the processing components of each independent subsystem. Where subsystems require special hardware or communications interfaces to support integration, the special hardware should be located near the independent subsystem processing components or network appliance, based on the manufacturers' recommendation. See the drawings for details on mounting locations.
  - 2. Infrastructure and Connectivity
    - a. Devices/Appliances: Appliances and devices shall be connected to their respective systems via the applicable communications network.
    - b. System LAN/WAN Connectivity: System Servers and microprocessor-based Control Panels, shall reside on the Local Area Network (LAN) or Wide Area Network (WAN) tier designated for integrated components.
- D. Attributes
  - 1. The attributes of the integrated environment are primarily defined by the subsystems that are to be integrated.
  - 2. Integrated systems comprise the processors, software, electrical control panels, data gathering panels, special data interfaces, and converters required to allow systems to communicate with each other, process information, and allow users to program and perform operations.
  - 3. The following systems will be a part of the integrated environment:
    - a. Electronic Access Control System (EACS)
    - b. Video Surveillance System (VSS) by others
- E. Functions
  - 1. The system shall provide the following automated processing rules, at a minimum:
    - a. The object of "Access Control system integration" is to automatically configure the system to display, record, and report appropriate system activity to various elements of the system. Automatic configuration can free operators from difficult control tasks, give the operator more time to respond to events, reduce operator error, and ensure critical system tasks occur consistently.
    - b. Access Control system elements (EACS) shall be electronically integrated in such a way as to enable video, video detection, database records and/or event- initiated instructions to be communicated between system components, to initiate recording, display, communication, and control activities.
    - c. Event-Initiated Interface, General:
      - 1) The system shall support the capability to send and receive alarm and control messages between the EACS and VSS systems via a LAN communications link, using API, XML, or other industry-standard communication languages and formats, and shall act upon those messages received.
      - 2) Where integration may require the implementation of RS-232 interfaces, Contractor shall propose such integration to the Owner for approval, before proceeding with the work.
      - 3) All software routines required to accomplish the required data-interface with external equipment and controls will be fully developed, installed, tested, and supported by the Contractor.

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- 4) The manufacturer of each applicable system will also support the data-interface and will be engaged by the Contractor to provide on-site technical assistance where required to prepare, repair, configure, and test the system to operational condition.
- 5) Communication of event information between systems shall take place automatically and immediately, when the event is sensed by the system.
- 6) "Hard-wired" interfaces used to support interactive video surveillance cameras, intelligent video, threat-based control, and other event-initiated functions shall not be acceptable, except as otherwise noted herein or shown on the design drawings.
- d. Intercom / Emergency Phone Integration
  - 1) Upon activation of the push button the system shall record an event in the EACS for date and time.
    - a) Activate a video camera where required by the Owner.
    - b) Start the process for voice communication with respondent.
- e. VSS Event-Initiated Control
  - 1) Upon receiving event/alarm information from the EACS, the VSS system shall transmit camera pre-positioning commands to applicable pan/tilt/zoom cameras, and shall cause the system to process, display, and record applicable cameras.
  - 2) The system shall automatically position and focus one or more cameras, or sequence of cameras, on nearby alarm locations. Coordinate with the Owner on initial and alarm preset camera views and programming.
  - 3) Configure systems to automatically send camera positioning and display commands from the EACS systems to the VSS Virtual Switching and Recording Software, based upon EACS event data. The system shall:
    - a) Automatically select, position, and focus one or more cameras on areas of concern;
    - b) Automatically re-configure recording for the selected cameras, to record them in an enhanced format, at the highest available resolution, frame rate, and quality (all other cameras remain at their pre-programmed format);
    - c) Automatically display the selected cameras on one or more monitors, client workstations, and other display devices, in a pre-selected configuration (single or multi-camera views).
- f. This interface shall be implemented using the integration scheme described herein.
- g. Recorder/Camera Control: Configure the EACS to allow control of the VSS system. At a minimum, the EACS should support the following VSS system functionality:
  - 1) Link alarms or events to a camera, with programmable pre-and post-alarm recording sequences.
  - 2) Fast-forward, rewind, pause, and print, pre-recorded video.
  - 3) View recorded video "tagged" or associated with EACS alarms or events.
  - 4) Access a Windows-style Tree view of connected cameras.
  - 5) Select camera icon from map to view live video.
  - 6) View a single live video feed in full-screen.
  - 7) View up to 4 simultaneous camera views in quad-view format.
  - 8) Receive and display digital video recorder generated alarms such as video loss and motion detection.
  - 9) Trigger conditional commands on digital video recorder generated alarms.
  - 10) Send video matrix commands via selected camera icon.
  - 11) View recorded video from History Activity report, and/or Alarm Monitor window.
  - 12) Identify alarms and events that have associated video available for review.
  - 13) Full video playback available at all EACS clients.

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- 14) View associated video from the Alarm Monitor window, based on reported alarms.
- 15) Provide both manual and preset pan-tilt-zoom control.

## **PART 2 - PRODUCTS**

**2.1 Not used. Refer to individual equipment sections for specified systems.**

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Provide the work in accordance with Section 28 05 00, Security Systems General Requirements.

### **3.2 COORDINATION**

- A. Provide the work in accordance with Section 28 05 00, Security Systems General Requirements.

### **3.3 WORKMANSHIP**

- A. Provide the work in accordance with Section 28 05 00, Security Systems General Requirements.

### **3.4 EQUIPMENT, RACK, AND CONSOLE INSTALLATION**

- A. Provide equipment, rack, and console installation in accordance with Section 28 05 00, Security Systems General Requirements.

### **3.5 GROUNDING PROCEDURES**

- A. Provide grounding of all systems and equipment in accordance with Section 28 05 00, Security Systems General Requirements.

### **3.6 CONDUIT AND WIRE INSTALLATION PRACTICES**

- A. Provide conduit, wire, and cable installation in accordance with Section 28 05 00, Security Systems General Requirements.

### **3.7 IDENTIFICATION AND TAGGING**

- A. Provide identification of wire, panels, and devices in accordance with Section 28 05 00, Security Systems General Requirements.

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### **3.8 DATABASE PREPARATION, CHECKING, AND ACTIVATION**

- A. Provide database preparation, checking and activation for systems and equipment in accordance with Security Systems General Requirements, Section 28 05 00.
- B. Contractor shall coordinate with the Owner to determine the required pre-programmed surveillance, rule-setting, and event-initiated configurations.

### **3.9 START-UP RESPONSIBILITY**

- A. Provide start-up services for systems and equipment in accordance with Security Systems General Requirements, Section 28 05 00.

### **3.10 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.

### **3.11 SYSTEM PERFORMANCE TESTING AND ADJUSTING PROCEDURES**

- A. Provide performance testing, burn-in, and adjusting of systems and equipment in accordance with Section 28 08 00, Testing and Commissioning.
- B. Performance Testing
  - 1. Demonstrate the operation of each camera that is associated with EACS monitoring or card reader points.
  - 2. Demonstrate automated call-up, pre-positioning and graphical map control of each camera, from the EACS GUI screens.

### **3.12 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.

### **3.13 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.

### **3.14 FINAL PROCEDURES**

- A. Perform final procedures in accordance with Section 28 05 00, Security Systems General Requirements.

END OF SECTION

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## **SECTION 280800 - SECURITY TESTING AND COMMISSIONING**

### **PART 1 - GENERAL**

#### **1.1 WORK INCLUDES**

- A. General Description: This specification section covers the provision of preliminary testing, acceptance testing, burn-in performance testing, and the commissioning of various access control systems at the MiraCosta Building 900.
- B. Provide Testing to assure that electrical equipment and wiring is operational, within industry and manufacturers tolerances and is installed in accordance with other sections of these specifications.
- C. Conduct tests in the presence of the Owner and the Owner's agents for the purpose of demonstrating the equipment or systems' compliance with specifications. Demonstrate electrical and mechanical tests to the Owner and the Owner's agents that the entire installation is functioning properly and that circuits, including power, control, instrumentation, relaying, integration, and communication, will function properly and as specified.
- D. Furnish, install and maintain tools, instruments, material, test equipment, test connections and power. Furnish personnel including supervision and "stand-by" labor required for the testing, setting, and adjusting of electrical facilities and component parts including putting the above into operation.
- E. Make tests with proper regard for the protection of equipment and personnel.
- F. Protect equipment from subsequent testing of other equipment and systems after equipment has been tested, checked for operation, and accepted by the Owner.
- G. Record test values of equipment, giving both "as-found" and "as-left" for existing conditions.
- H. The witnessing of any test by the Owner does not relieve the Contractor of warranties for material, equipment, and workmanship, as specified in the General Conditions.
- I. Check circuits for conformance with the wiring diagrams furnished by manufacturers.

#### **1.2 RELATED SECTIONS AND REFERENCES**

- 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 Section 28 05 00, Security System General Requirements
- C. In accordance with Section 28 05 53, Identification for Electronic Safety and Security
- D. In accordance with Section 28 07 00, Security System Integration
- E. In accordance with Section 28 08 00, Security System Testing and Commissioning

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- F. Inspections and tests shall be performed in accordance with applicable codes and standards including the most current versions of NEC, ANSI, IEEE, NFPA, NEMA and OSHA.
- G. International Electrical Testing Association, Acceptance Testing Specifications (NETA ATS), latest edition.

### **1.3 SUBMITTALS**

- A. In addition to the requirements of Section 28 05 00, four (4) bound copies of the certified test reports shall be submitted to the Owner within seven (7) days after the completion of the work. The final report shall be signed and include the following information:
  - 1. Summary of the project.
  - 2. Description of the equipment tested.
  - 3. Visual inspection report
  - 4. Description of the tests
  - 5. Pre-Acceptance and Final Acceptance Test results
  - 6. Conclusions and recommendations
  - 7. Appendix including appropriate test forms
  - 8. Identification of the test equipment used

### **1.4 WARRANTY**

- A. Provide the work in accordance with Section 28 05 00, Security Systems General Requirements.

## **PART 2 - PRODUCTS**

NOT USED

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Furnish labor, instruments, products, temporary power, and sufficient materials required for testing at each test.
- B. Correct deficiencies found as a result of tests and make replacements or repairs to tested products that are damaged as the result of the tests. This included Burn In Performance report reviews
- C. Schedule tests at a time convenient to witnesses thereto or persons affected by the tests.
- D. Provide fourteen (14) day written notification to the Owner for test procedures prior to the test.
- E. Make records of all tests in a neat and legible form. Identify the equipment or system tested and the test data.

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- F. Check control, instrumentation, and power cables and conductors for proper connections, workmanship, and identification.
- G. Test disconnect switches through an open and closed cycle for proper operation, alignment, and contact.
- H. Additional tests required shall be as outlined under the various Sections of Division 26 and 28.
- I. Submit to the Owner certified reports on all tests indicating full compliance with test requirements.

### **3.2 COORDINATION**

- A. Provide the work in accordance with Section 28 05 00, Security System General Requirements.

### **3.3 WORKMANSHIP**

- A. Provide the work in accordance with Section 28 05 00, Security System General Requirements.

### **3.4 PRELIMINARY INSPECTION & TESTING**

- A. Coordination: Coordinate testing of components of the system in cooperation with other trades.
- B. Verification: Prior to performing Preliminary Testing, inspection, and/or final testing procedures, Contractor shall insure the following:
  - 1. Safe and proper operation of all components, devices or equipment, and the absence of extraneous or interfering signals
  - 2. Proper grounding of devices and equipment
  - 3. Integrity of signal and electrical system ground connections
  - 4. Proper powering of devices and equipment
  - 5. Integrity of all insulation, shield terminations and connections
  - 6. Integrity of soldered connections and absence of solder splatter, solder bridges, debris of any kind
  - 7. Proper dressing of wire and cable with labels matching as-build documents
  - 8. "Wire-checking" of all circuitry, including phase and continuity
  - 9. Preliminary targeting and setup of video camera assemblies
  - 10. Mechanical integrity of all support and positioning provisions, i.e.: as provided for video cameras, monitors, and any other equipment
  - 11. Sequencing: If applicable, determine and record the sequence of energizing systems to minimize the risk of damage from improper startup
  - 12. Proper operation of devices and systems in accordance with specified performance requirements
  - 13. System is programmed for alarm reporting of each device and associated with the graphical maps
  - 14. Verify system programming is defined.
  - 15. Verify with Owner the provided designations for all devices.
- C. Perform a Preliminary Inspection and Test to determine the operating status of components and systems prior to Final Acceptance Testing.
  - 1. Testing Security Equipment, Enclosures, and Cabinets
    - a. Test each equipment enclosure for tamper alarm
    - b. Test each power supply battery for power loss alarm reporting

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- c. Test 120VAC power loss alarm
- d. Test for communication loss with server reporting
- 2. Test power stand-by provisions (UPS, battery backup, generator backup)
- 3. Testing Electronic Access Control Doors
  - 1) Doors with Door Position Switch (DPS) and Request to Exit device (REX) shall be tested for:
    - a) Door Forced Open alarm is generated when door is opened from unsecured side
    - b) Door Held Open alarm is generated when door is held open past its preprogrammed duration after valid REX event
    - c) REX shunts alarm on egress
    - d) REX does not shunt forced door alarm
  - 2) Doors with Electrified Exit Device, DPS and REX
    - a) Door is locked in secure mode
    - b) Door is unlocked by manual command from system workstation
    - c) Door is unlocked by time zone
    - d) Door Forced Open alarm is generated during secure mode only
    - e) Door Held Open alarm is generated during secure mode only
    - f) REX shunts alarm on egress during secure mode, for the preprogrammed duration
    - g) Door relocks immediately when door closes after valid passage (does not wait for preprogrammed duration)
    - h) REX does not unlock door
    - i) REX does not bypass forced door alarm
    - j) Door relocks on time zone
    - k) Door relocks during day mode on manual command from system workstation
  - 3) Doors with Automatic door operators
    - a) Door is locked in secure mode
    - b) Door is unlocked by manual command from system workstation during secure mode
    - c) Door is unlocked by time zone
    - d) Door Forced Open alarm is generated during secure mode only
    - e) Door Held Open to long alarm is generated during secure mode only
    - f) REX shunts alarm on egress during secure mode
    - g) REX does not unlock door
    - h) Door relocks on time zone
    - i) Door relocks during day mode on manual command from system workstation.
  - 4) Doors or Gates with card reader
    - a) Door unlocks by use of the card reader for programmed unlock time and does not alarm when door is opened
    - b) Door is locked in secure mode
    - c) Door is unlocked by manual command from system workstation
    - d) Door is unlocked by time zone
    - e) Door Forced Open alarm is generated during secure mode
    - f) Door Held Open alarm is generated during secure mode
    - g) REX shunts alarm on egress during secure mode
    - h) Door relocks immediately when door closes after valid passage (does not wait for preprogrammed duration)
    - i) REX for door does not unlock door
    - j) REX for gates does not unlock gate
    - k) Door relocks on time zone
    - l) Door relocks during day mode on manual command from system workstation

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- 5) Doors with card and/or biometric iris and/or fingerprint reader
  - a) Door unlocks by use of the card or iris reader for programmed unlock time and does not alarm when door is opened
  - b) Door is locked in secure mode
  - c) Door is unlocked by manual command from system workstation
  - d) Door is unlocked by time zone
  - e) Door Forced Open alarm is generated during secure mode
  - f) Door Held Open alarm is generated during secure mode
  - g) REX shunts alarm on egress during secure mode
  - h) Door relocks immediately when door closes after valid passage (does not wait for preprogrammed duration)
  - i) REX for door does not unlock door
  - j) Door relocks on time zone
  - k) Door relocks during day mode on manual command from system workstation
- D. Adjustments and Documentation: After successfully energizing and testing the systems, make adjustments, and document the setting of controls, configurations, as applicable. Tabulate all data along with an inventory of test equipment, a description of testing conditions and a list of test personnel.
- E. Test Documentation: Create and provide complete test reports documenting the results of the each performed on each device, control panel, power supply, and other elements of the system. Copies of preliminary test data shall accompany copies of performance testing data as part of the Operating and Maintenance submittal.

### **3.5 PREPARATION FOR ACCEPTANCE (PRIOR TO FINAL INSPECTION)**

- A. Temporary facilities and utilities shall be properly disconnected, removed, and disposed of off-site.
- B. Systems, equipment, and devices shall be in full and proper adjustment and operation, and properly labeled and identified.
- C. Materials shall be neat, clean, and unmarred, and parts securely attached.
- D. Broken work, including glass, raised flooring, and supports, ceiling tiles and supports, walls, doors, etc., shall be replaced or properly repaired, and debris cleaned up and appropriately discarded.
- E. Extra materials as specified shall be delivered and stored at the premises as directed by the Owner at the completion of the phase.
- F. Preliminary Test reports of each system and each system component, and Record project documents shall be complete and available for inspection and delivery upon completion of each phase as directed by Owner.

### **3.6 ACCEPTANCE TESTING AND ADJUSTING PROCEDURES**

- A. Purpose: Conduct testing and adjusting procedures to realize and verify the performance criteria specified herein and identified in Preliminary Testing procedures listed above. Successfully

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demonstrate the acceptable performance of each specified system in the presence of the Owner and Engineer.

- B. Scope: Conduct all performance testing, adjustment, and documentation procedures to verify and realize compliance with the performance specifications herein. Make available at least one (1) engineer familiar with this work, and all required test equipment for the duration of performance testing verification, at the convenience of the Owner.
- C. Acceptance Testing Readiness: Acceptance testing will be performed after the system is installed and pre-tested completely.
  - 1. The contractor shall have successfully tested the system prior to scheduling formal acceptance testing and provided forms with each test for each portal. Contractor shall correct any and all deficiencies found at that time.
  - 2. Acceptance testing will be conducted in accordance with the approved Acceptance Testing Plan with a minimum of testing listed in Preliminary Testing section.
  - 3. Deliver equipment, devices and materials required for the access control work to the site at least fourteen (14) working days prior to the scheduled Completion Date.
  - 4. Install, test and ready all of the access control work for final Acceptance Testing of the Installation ten (10) working days prior to the Completion Date.
- D. Acceptance Testing Schedule: Contractor shall confirm in writing to the Owner when the system is ready for acceptance testing. Contractor shall then schedule a complete Acceptance Test at the convenience of the Owner.
- E. Acceptance Testing
  - 1. Contractor shall test and verify the performance of all equipment, systems, interfaces and peripheral equipment in the presence of the Owner and Engineer.
  - 2. Tests shall be performed in accordance with the requirements of individual systems as specified herein and in related specification sections. Test shall incorporate testing described in preliminary inspection and testing.
  - 3. Contractor shall furnish communication equipment between the field testing team and the monitoring team.
  - 4. Contractor shall furnish testing forms for each location.
- F. An Observation Report will be generated by the reviewing team, Owner, Design Engineer and Contractor for contractor to review.
- G. Correction of Jobsite Observation Report Items: Perform any and all remedial work to correct inadequate performance or unacceptable conditions of, or relating to any of this work, as determined by the Owner within ten (10) working days of the completion date. Corrective work shall be performed at no additional cost to the Owner. Contractor shall provide a written report each week of repairs made and plan to complete repairs in progress.
- H. Test Documentation: Document all acceptance testing, calibration and correction procedures described herein with the following information:
  - 1. Performance date of the procedure
  - 2. The names of personnel conducting the procedure
  - 3. The equipment used to conduct the procedure
  - 4. Type of procedure and description
  - 5. Condition during performance of procedure
  - 6. Parameters measured and their values, including values measured prior to calibration or correction as applicable



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### **3.7 BURN-IN PERFORMANCE PERIOD**

- A. Prior to Final Acceptance by the Owner, the Contractor shall be responsible for performing testing and inspections, as specified herein, to verify that the installation equipment and materials are performing in compliance with the specifications.
- B. Upon satisfactory completion of Acceptance Testing and inspection, the Owner shall notify the Contractor, and the Burn-In Performance Period shall commence.
- C. Contractor shall obtain weekly reports of alarm events related to this project and make system repairs or corrections to minimize false alarms. A report shall be provided by the Contractor to the Owner indicating corrections required and locations corrected. Engineer may provide additional comments to the report for contractor to review and provide corrective action.
- D. A Performance Period of thirty (30) consecutive calendar days of operating without fault in accordance with the specifications, subsequent to testing and inspection, shall constitute a successful Performance Period.
- E. Upon successful completion of the Performance Period, the Owner and design team shall meet to confirm Acceptance, and the Final Acceptance Form shall be executed.
- F. If a successful Performance Period cannot be accomplished within ninety (90) consecutive calendar days after commencement of the first Performance Period, the Owner reserves the right to find the Contractor in default, and terminate the Contract. In that event, the Contractor shall remove the equipment, and the Owner shall not be responsible for any payment whatsoever to the Contractor, except for any materials (i.e., wiring) left in place and elected to be reused by the Owner.
- G. Obtain system alarm and event reports at a minimum of four (4) times during the burn in period. Review reports with Owner and repair system equipment and/or adjust system parameters as requested by the Owner or required for system performance.

### **3.8 COMMISSIONING AND VALIDATION**

- A. Commissioning is a "fine tuning" process used for complex systems that occurs after acceptance testing, during the Burn-In Performance period and before final acceptance. It helps assure that the system performs to its fullest potential and validates the effectiveness of the total system implementation in relation to the goals of the access control countermeasures program.
- B. After the installation and final testing of the system, an Access Control Commissioning team will be assembled to validate the best performance of the system under different scenarios. Alarm reports shall be used to verify operation of the system.
- C. This process includes participation by the Owner, Contractor, the Consulting Engineer, A third party testing agent may also be hired by the Owner to plan, conduct, and verify the Commissioning process.
- D. The Contractor shall include a minimum of sixteen (16) hours of participation in the commissioning and validation process by a minimum of two (2) employees familiar with the specific project and installation. Contractor shall adjust device installation where alarms are determined to be false.
- E. Scheduling of Commissioning and Validation testing will be by the Owner, and may occur after the Notice of Completion, but before the end of the Warranty period.

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- F. Revisions to the configuration and programming of the system which are recommended by the Commissioning Team as a result of validation testing, shall be performed by the Contractor under the direction of the Owner, at no additional charge. The Warranty provisions of this specification shall apply to any configuration and programming revisions resulting from the validation testing process.
- G. Revisions and improvements recommended by the Commissioning Team which require physical modifications or additions to the approved and accepted system, including the provision or relocation of new equipment, wiring, and installation, shall be treated as additional changes to the contract, and shall be processed as defined in the Project General Provisions. Where such requested work was part of the Contractors' original scope of work, as defined in the design drawings and specifications, or in contract revisions and agreements, the Contractor shall provide the work at no additional charge.

### **3.9 FINAL PROCEDURES**

- A. Perform final procedures in accordance with Section 28 05 00, Security System General Requirements.

END OF SECTION

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## **SECTION 281300 - 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 Building 900.
- 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 Section 28 05 00, Security System General Requirements
- C. In accordance with Section 28 05 53, Identification for Electronic Safety and Security
- D. In accordance with Section 28 07 00, Security System Integration
- E. In accordance with Section 28 08 00, Security System Testing and Commissioning

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## **1.5 APPLICABLE PUBLICATIONS**

- A. In accordance with Section 28 05 00, Security System General Requirements

## **1.6 SHOP DRAWINGS & EQUIPMENT SUBMITTAL**

- A. In accordance with Section 28 05 00, Security System General Requirements

## **1.7 OPERATING AND MAINTENANCE MANUALS**

- A. In accordance with Section 28 05 00, Security System General Requirements.

## **1.8 SERVICE AND MAINTENANCE**

- A. In accordance with Section 28 05 00, Security System General Requirements

## **1.9 TRAINING**

- A. In accordance with Section 28 05 00, Security System General Requirements

## **1.10 WARRANTY**

- A. In accordance with Section 28 05 00, Security System General Requirements

## **1.11 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 MiraCosta Building 900. 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.

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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

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- 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.

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- 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 outside building 900.
      - 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.

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## 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 Multiclass SE RP40 reader, part # 920PTNNEK00000
    - 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.

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- 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 Multi Class SE 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

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- 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 Life Safety Power FPO150/250 – 3D8P2M8NL4E4M1.
      - 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.
      - 7) Power supply must include Low Power Disconnect (LPD) Module.
    - 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).

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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:

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- 1) GE 2500 series Form A 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) Sentrol 1076D-G (DPDT) Concealed Magnetic Door Switch.
- c. Gates and Roll-Up Doors:
  - 1) Sentrol 2205A 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 Building 900. 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
    - a. 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.
    - b. The system shall be U.L. listed for Central Station, Local and Auxiliary, and Burglary (UL Central Station and Local) applications.
    - c. 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

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- system status information by voice. The system shall include a pre-recorded word library from which words can be selected to create zone labels.
- d. 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
  - e. Parts:
    - 1) Provide: D7412GV4 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 15 00.
- C. Cable installed below grade shall be rated for immersion in water.

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## **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. Many of the doors in this project are existing and will be reused. Site verification and coordination with General Contractor
  - 2. Doors shall not be locked in path of legal egress.
  - 3. 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.
  - 4. 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.
  - 5. 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.
  - 6. Security contractor to provide and install required lock power supplies for all electrified door hardware. Coordinate AC power requirements with electrical contractor.
  - 7. 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.
  - 8. 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.

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- 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.

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- 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:

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- 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.

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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

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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.
- B. Access Control Panel/Power Supply Enclosure
  1. Contractor shall provide proper wire management of reader boards attached to interior of door within the enclosure. Contractor shall ensure opening of the enclosure will not disrupt connections to boards.

### **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.

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### **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.

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### **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

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## **SECTION 28 31 11**

### **DIGITAL ADDRESSABLE FIRE ALARM SYSTEM**

#### **PART 1 - GENERAL**

##### **1.01 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.

##### **1.02 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.

##### **1.03 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

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- 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).

#### 1.04 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:

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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 reproductions, 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.

## **1.05 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.



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- a. 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.
  2. 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.)
  3. 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.
  4. The system contractor shall prove the ability to provide emergency restoration service within 12 hours by factory-certified personnel.
  5. 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.

## **1.06 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**

### **2.01 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, FATCs, initiating devices, notification appliances, relay modules, FATCs, batteries and battery cabinets, annunciator panels, metallic conduit, boxes, wiring, and other components as required for a functional system.

### **2.02 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.

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1. Exception: Provide College's standard devices where specified or required.

## **2.03 FIRE ALARM CONTROL PANEL**

- A. The fire alarm control panel shall be manufactured by Notifier to match College standard, (Model: 320, 640, 3030 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:
    - a. Block Acknowledge.
    - b. Charger Rate Control.
    - c. Control-By-Time.
    - d. Automatic Day/Night Sensitivity Adjust.
    - e. Device Blink Control.
    - f. Drift Compensation.
    - g. Pre-alarm Control Panel Indication.
    - h. NFPA 72 Smoke Detector Sensitivity Test.
    - i. System Status Reports.
    - j. Alarm Verification, by device, with tall.
    - k. Multiple Printer Interface.
    - l. Multiple CRT Display Interface.
    - m. Non-Alarm Module Reporting.
    - n. Periodic Detector Test.

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- o. Trouble Reminder.
- p. Upload/Download to PC Computer.
- q. Alarm Verification with Tally.
- r. Walk Test.
- s. 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.

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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 FACPs 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
26. 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.
27. 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.
28. Shall be capable of secure access to the Voice Evacuation/Mass Notification panel via cell

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- phone or other remote telephone.
29. 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).
  30. 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.
  31. 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.

D. 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.

E. 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.

F. 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.

G. 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

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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.

H. 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.

I. 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.

J. 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.

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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.
- K. 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.
- L. 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.
- M. 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.
- N. 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.
    - a. 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.
- O. 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.
- P. 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.



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- Q. 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.
- R. 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.
- S. 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:
    - a. Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad.
    - b. System output points shall be capable of being turned on or off from the system keypad.

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4. 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:
  - a. Device Status.
  - b. Device Type.
  - c. Custom Device Label.
  - d. Software Zone Label.
  - e. Device Zone Assignments.
  - f. Analog Detector Sensitivity.
  - g. All Program Parameters.
5. 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.
  - a. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable.
6. Automatic Detector Maintenance Alert: The FACP shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.
7. 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.
8. 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.
9. 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.

## **2.04 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.



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## **2.05 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.

## **2.06 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.

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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.

## **2.07 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.

## **2.08 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.

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- 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.

## **2.09 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.

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- 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

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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 sans-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

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- 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 FACPs, 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**

## **3.01 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. FACPs shall be located in approved electrical rooms.
  1. Mount FACPs, 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.



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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.
    - a. Exception: Miniature monitor modules may be installed within interior or weatherproof exterior manual fire alarm station backboxes.
  11. 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.
  12. 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.
  13. 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.
  14. 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.
  15. Penetrations of fire-rated construction shall be firestopped using an approved, listed through-penetration firestop system as specified in Division 7 Section "Firestopping."
  16. 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.
  17. FACP batteries shall be installed in battery cabinets as per 2.14.
  18. 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.
    - a. 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.

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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).
    - a. Exception: visual annunciator circuit wiring and post indicator valve tamper switch circuit wiring.
  5. 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.
    - a. Exception: devices available only with "pig-tail" connections shall be connected to the circuit wiring using approved insulated wire nuts.
  6. 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.
    - a. Exception: in an FATC other than the main FATC or a floor FATC, the second terminal block and cross-connect jumpers may be omitted.
  6. 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.
  7. There shall be 10 percent spare sets of terminals, minimum of 12 sets, installed in each main and floor FATC.
  8. 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.
  9. 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.



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- a. 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.
- 10. 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:
    - a. Where required by code.
    - b. In electrical, mechanical, and machine rooms.
    - c. Where exposed to weather (PVC-coated).
    - d. Where exposed and below 7 feet 6 inches above finished floor.
      - 1) Exception: Occupied or finished spaces.
    - e. Where in slabs or in concrete (PVC-coated).
    - f. Where exposed to physical damage.
    - g. In corrosive areas (PVC-coated).
    - h. In damp or wet locations (PVC-coated).
  - 2. All system wiring shall be installed in conduit independent of all other electrical circuits.
  - 3. 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.
    - a. 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.
    - b. 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.
  - 4. 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.
    - a. Exception: for risers connecting floor FATC's, initiating device circuits, signaling line circuits, and notification appliance circuits may be installed in the same conduit.
  - 5. Maximum conduit fill shall be 75 percent of that permitted by the California Electrical Code.
  - 6. All system conduit shall be red color--All junction box covers shall be externally identified by permanent red paint suitable for the purpose.

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- a. Conduit containing auxiliary circuit wiring as defined in 1.2.2 are not to be so identified.
  7. Magnetic door holding circuits and other non-power limited circuits shall be in separate raceway.
  8. 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.
  9. Conduit shall be arranged such that only those wires directly serving a duct detector are routed through its housing.
  10. 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.
    - a. 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.
  3. 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.
  4. 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.
    - a. 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.
  5. 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.

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- a. 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.
6. 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.

### **3.02 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).

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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:
    - a. By building.
    - b. By floor.
    - c. By wing or fire area.
    - d. At both ends of every underground circuit.
    - e. There shall be a minimum of 10 percent spare capacity for additional devices between each pair of isolators/isolation modules.
  8. Resetting of all devices shall be a single operation accomplished at the FACP.
  9. Silencing of an alarm shall not prevent subsequent initiating devices from initiating and indicating an alarm in a non-interfering manner.
    - a. 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.

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- 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.

### **3.03 IDENTIFICATION**

- A. Provide identification of equipment and materials.

### **3.04 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.

### **3.05 DOCUMENTATION**

- A. Copies of complete as-built installation wiring documentation, internal FACP schematics, and maintenance manuals are to be submitted prior to final acceptance.

### **3.06 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.

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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.

### 3.07 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.

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- B. A typewritten "Sequence of Operation" shall be provided.

END OF SECTION



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## **SECTION 32 13 13 CONCRETE PAVING**

### **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. The Contractor shall furnish all materials for concrete in accordance with the provisions of this Section and shall form, mix, place, cure, repair, finish, and do all other work as required to produce finished concrete, in accordance with the requirements of the Contract Documents.
- B. Provide curb cuts meeting the accessibility requirements of the California Code of Regulations (CCR) Title 24, Part 2, 1127B.5, and ramps complying with CCR, T24, CCR, Part 2, 1003.3.4 and 11B-406.
- C. Portland cement concrete paving shall be stable, firm, and slip resistant and shall comply with CBC Sections 11B-302 and 11B-403.
- D. The following types of concrete shall be covered in this Section:
  - 1. Portland cement concrete pavement, cement walks, flatwork, curbs, gutters, retaining curbs, swales, trash pick-up areas, ramps, mowing strips, fence post footings, sliding gate concrete, catch basins, pipe bedding and encasements, transition structures, flagpoles and light standard bases and footings, splash blocks, parking bumpers and equipment pads.
- E. Reference Standards:
  - 1. The work provided herein shall conform to and be in accordance with the Contract Plans, General Conditions/Specifications and Special Provisions, as well as the Standard Specifications for Public Works Construction (GREENBOOK), Current Edition, adopted by the Southern California Chapter, American Public Works Association; herein referred to as the "Standard Specifications".
  - 2. Comply with the current provisions of the following Codes and Standards:
    - a. UU-B-790: Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellant and Fire Resistant).
    - b. ACI 301: Specifications for Structural Concrete for Buildings.
    - c. ACI 318: Building Code Requirements for Reinforced Concrete.
    - d. ASTM C31: Practices for Making and Curing Concrete Test Specimens in the Field.
    - e. ASTM C33: Specification for Concrete Aggregates.
    - f. ASTM C39: Test Method for Compressive Strength of Cylindrical Concrete Specimens.
    - g. ASTM C40: Test Method for Organic Impurities in Fine Aggregates for Concrete.
    - h. ASTM C42: Methods of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
    - i. ASTM C78: Specification for Flexural Strength.
    - j. ASTM C88: Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate.
    - k. ASTM C94: Specification for Ready-Mixed Concrete.
    - l. ASTM C114: Method for Chemical Analysis of Hydraulic Cement.
    - m. ASTM C131: Test Method for Resistance to Degradation of Small- Sized Coarse



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- Aggregate by Abrasion and Impact in the Los Angeles Machine.
- n. ASTM C136: Method for Sieve Analysis of Fine and Coarse Aggregate.
- o. ASTM C143: Test Method for Slump of Portland Cement Concrete.
- p. ASTM C150: Specification for Portland Cement.
- q. ASTM C156: Test Method for Water Retention by Concrete Curing Materials.
- r. ASTM C157: Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete.
- s. ASTM C172: Specification for Sampling Fresh Concrete.
- t. ASTM C192: Method of Making and Curing Concrete Test Specimens in the Laboratory.
- u. ASTM C260: Specification for Air-Entraining Admixtures for Concrete.
- v. ASTM C311: Method for Sampling and Testing Fly Ash or Natural Pozzolans for Use as Mineral Admixture in Portland Cement Concrete.
- w. ASTM C494: Specification for Chemical Admixtures for Concrete.
- x. ASTM C618: Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement.
- y. ASTM C979: Specification for Pigments for Integrally Colored Concrete.
- z. ASTM D1751: Specification for Performed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
- aa. ASTM E119: Method for Fire Test of Building Construction and Materials.
- bb. ASTM C1549: Method for Determination of Solar Reflectance.

### 1.3 SUBMITTALS

- A. Submittals shall be made in accordance with General Requirements.
- B. The following submittals and specific information shall be provided:
  - 1. Mix Designs - Prior to beginning the work, the Contractor shall submit to the Engineer, for review, and approval, preliminary concrete mix designs for each class and type of concrete specified herein. The mix designs shall be designed by an independent testing laboratory acceptable to the Engineer. All costs related to such mix design shall be borne by the Contractor:
    - a. Each concrete mix submittal shall contain the following information:
      - 1) Slump on which the design is based.
      - 2) Total gallons of water per cubic yard.
      - 3) Brand, type, composition and quantity of cement.
      - 4) Brand type, composition and quantity of fly ash.
      - 5) Specific Gravity and gradation of each aggregate.
      - 6) Ratio of fine to total aggregate per cubic yard.
      - 7) Weight (surface dry) of each aggregate per cubic yard.
      - 8) Brand, type, and ASTM designation, active chemical ingredients and quantity of each admixture.
      - 9) Copy of the Building and Safety Research Report Approval for each concrete admixture.
      - 10) Air content.
      - 11) Compressive strength based on 7 day and 28 day compression tests, including standard deviation calculations, corroborative data (if applicable), and required average comprehensive strength per ACI 318.
      - 12) Time of initial set.
      - 13) Certification stamp and signature by a Civil or Structural engineer registered in state of California.
      - 14) Certificate of Compliance for Cement.
      - 15) Test Data: ASTM C1549 Solar Reflectance. Submit test reports of proposed mix certifying solar reflectance meets project requirements.
  - 2. Certified Delivery Tickets: Where ready-mix concrete is used, the Contractor shall

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provide certified weighmaster delivery tickets at the time of delivery of each load of concrete. Each certificate shall show the public weighmaster's signature, and the total quantities, by weight of cement, sand, each class of aggregate, admixtures, and the amounts of water in the aggregate and added at the batching plant as well as the amount of water allowed to be added at the site for the specific design mix. Each certificate shall, in addition, state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to when the batch was dispatched, when it left the plant, when it arrived at the job, the time that unloading began, and the time that unloading was finished.

3. When a water reducing admixture is to be used, the Contractor shall furnish mix designs for concrete both with and without the admixture.
4. The Contractor shall furnish a Certificate of Compliance signed by the supplier identifying the type of fly ash and stating that the fly ash complies with ASTM C618 and these Specifications, together with all supporting test data prior to the use of the fly ash the sample represents. The supporting data shall also contain test results confirming that the fly ash in combination with the cement and water to be used meets all strength requirements and is compatible with air- entraining agents and other admixtures.
5. The Contractor shall submit to the Engineer for review the design mix for fly ash concrete together with the design mix for portland cement (non-fly ash) concrete as specified in this Section.

#### 1.4 QUALITY ASSURANCE

- A. Testing for Portland Cement Concrete shall be sampled and tested in accordance with the ASTM and California Tests listed in the Standard Specifications for Public Works Construction, Current Edition, Section 201-1.1.5.
- B. Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, or not less than once for each 50 cubic yards of concrete, or not less than once for each 2,000 square feet of surface area for slabs. Additional samples for seven-day compressive strength tests shall be taken for each class of concrete at the beginning of the concrete work or whenever the mix or aggregate is changed.
- C. The cost of all laboratory tests on cement, aggregates, and concrete, will be borne by the Contractor.
- D. Concrete for testing shall be supplied by the Contractor at no cost to the Owner, and the Contractor shall provide assistance and facilities to the Inspector in obtaining samples, and disposal and cleanup of excess material.
- E. Curbs and gutters shall be staked by a Land Surveyor licensed to practice in the State of California.
- F. Job Mock-Up:
  1. General:
    - a. Make samples on-site; revise as required; obtain Architect's approval, 10 days prior to casting finished work.
    - b. Finished work to match approved samples.
    - c. Approved sample may be incorporated into the work. Retain samples until completion of all concrete work.
    - d. Include typical tooled joint control in sample.
  2. Color Cured Hardened Slab; Interior Slab-On-Grade: Provide sample, 20 s.f. minimum area.
  3. Broom Finished Concrete; Exterior Flatwork: Provide sample, 20 s.f. minimum area.
  4. "Sacked" Vertical Surface; Exterior Wall: Provide sample, 5 sf. minimum area.

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- G. Construction Tolerances: The Contractor shall set and maintain concrete forms and perform finishing operations so as to ensure that the completed work is within the tolerances specified herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades, or dimensions shown.
- H. Construction tolerances shall not violate dimensions, grades, slopes required by CBC for accessibility requirements. Adjust work accordingly to comply with requirements.
- I. The following construction tolerances are hereby established and apply to finished walls and slab unless otherwise shown:

Item	Tolerance
Variation of the constructed linear outline from the established position in plan.	In 10 feet: 1/8-inch; In 20 feet or more: 1/4-inch
Variation from the level or from the grades shown.	In 10 feet: 1/8-inch; In 20 feet or more: 1/4-inch
Variation from the plumb	In 10 feet: 1/8-inch; In 20 feet or more: 1/4-inch
Variation in the thickness of slabs and walls.	Minus 1/8-inch; Plus 1/4-inch
Variation in the locations and sizes of slabs inch and wall openings.	Plus or minus 1/8-

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Only one brand of cement shall be used. Cement reclaimed from cleaning bags or leaking containers shall not be used. All cement shall be used in the sequence of receipt of shipments.
- B. All materials furnished for the work shall comply with the requirements of ACI 301, as applicable.
- C. Storage of materials shall conform to the requirements of ACI 301.
- D. Form Materials - Plywood, metal, metal-framed plywood, or other acceptable panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces. Conform to Section 303-5.2 of the Standard Specifications:
  - 1. Use flexible or curved forms for curves of a 100-foot or less radius.
  - 2. Wood form material, profiled to suit conditions:
    - a. Materials shall be free from defects which would impair the appearance of structural quality of the completed work
    - b. Provide stakes and bracing materials as required to hold forms securely in place.
- E. Reinforcing Materials:
  - 1. Steel Reinforcing Bars: ASTM A615/A615M deformed grade 80 (80,000 psi) yield strength billet steel, unfinished, unless otherwise specified on Construction Document.

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Fabrication, sampling and jobsite handling shall conform to the requirements in ASTM D3963, except the 2 samples shall be 30 inches long.

2. Steel Welded Wire Reinforcement: Plain type, ASTM A1064/A1064M; in flat sheets; unfinished.
3. Dowels:
  - a. Dowel bars shall be plain round smooth conforming to the requirements in ASTM A615/A615M, Grade 60 (60,000 psi) yield strength, except that the two samples required in ASTM D3963/D3963M shall be 18 inches long. Dowel bars shall be free from burrs or other deformations detrimental to free movement of the bars in the concrete.
  - b. Dowel bars shall be lubricated with a bond breaker over the entire bar. A bond breaker application of petroleum paraffin based lubricant or white- pigmented curing compound shall be used to coat the dowel bars completely prior to placement. Oil and asphalt based bond breakers shall not be used. Paraffin based lubricant shall be Dayton Superior DSC BB-Coat or Valvoline Tectyl 506 or an approved equal. Paraffin based lubricant shall be factory applied. White pigmented curing compound shall conform to the requirements of ASTM Designation C309, Type 2, Class A, and shall contain 22 percent minimum nonvolatile vehicles consisting of at least 50 percent paraffin wax. Curing compound shall be applied in 2 separate applications, the last application not more than 8 hours prior to placement of the dowel bars. Each application of curing compound shall be applied at the approximate rate of one gallon per 15 square yards.
4. Epoxy for bonding tie bars and dowel bars to portland cement concrete shall be a two-component, epoxy-resin, conforming to the requirements of ASTM C881, Type V, Grade 3 (Non-Sagging), Class B or C. The class used shall be dependent on the internal temperature of the hardened concrete at the time the epoxy is to be applied. Class B shall be used when the internal temperature is from 40 °F to 60 °F. Class C shall be used when the internal temperature is above 60 °F, but not higher than recommended by the manufacturer. A copy of the manufacturer's recommended installation procedure shall be provided to the Engineer at least 7 days prior to the start of work. Epoxy shall be applied in conformance with the manufacturer's recommendations:
  - a. Simpson Strong Tie Set-XP Epoxy (or approved equal) ICC-ES ESR- 2508.

F. Concrete Materials:

1. Provide in accordance with State of CA Highways (CalTrans) standards.
2. Site concrete shall be standard brand portland cement conforming to ASTM C150, 80% Type II or Type V with 20% Class F fly ash. A water-reducing admixture conforming to section 2.01, part G.4 herein must also be used. A single brand of cement shall be used throughout the work, and prior to its use, the brand shall be acceptable to the Engineer. The cement shall be suitably protected from exposure to moisture until used. Cement that has become lumpy shall not be used. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling. Certified mill test reports for each shipment of cement to be used shall be submitted to the Inspector.
3. Concurrent with strength design criteria, concrete shall also be proportioned to provide the requisite durability to satisfy the exposure conditions imposed by either environment and/or service. Durability, in this context, refers to the ability of the concrete to resist deterioration from the environment or service in which it is placed. Concrete proportioned in accordance with ACI 318, chapter 4, Durability Requirements, will meet this criteria.
4. Combined Aggregate: 1" maximum coarse aggregate size conforming to Grading C of Standard Specifications Section 201-1.3.2(A). Aggregates shall be obtained from pits acceptable to the Inspector, shall be non-reactive, and shall conform to ASTM C33.
5. Water: Shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts and other impurities. The water shall be considered potable, for the

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purposes of this Section only, if it meets the requirements of the local governmental agencies.

6. **"Pea gravel" mix is not acceptable**, unless specifically approved in writing by the Civil Engineer of Record prior to construction.

G. Admixtures:

1. The Engineer may require the use of admixtures or the Contractor may propose to use admixtures to control the set, effect water reduction, and increase workability. In either case, the addition of an admixture shall be at the Contractor's expense. The use and continued use of an admixture shall be approved by the Engineer. Admixtures specified herein, other than calcium chloride, shall conform to the requirements of ASTM C494. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used. Admixtures shall contain no free chloride ions, be non-toxic after 30 days, and shall be compatible with and made by the same manufacturer as the air entraining admixture.
2. These admixtures shall not be used in greater doses than those recommended by the manufacturer or permitted by the Engineer. The permitted dosage of the admixture shall not exceed that which will result in an increase in the driving shrinkage of the concrete in excess of 20 percent when used in precast or prestressed concrete, or 10 percent when used in any other structural concrete. The strength of concrete containing the admixture in the amount of proposed shall, at the age of 48 hours and longer be not less than that of similar concrete without the admixture. The admixture shall not adversely affect the specified air content, unless permitted by the Engineer.
3. Set controlling admixture shall be either with or without water-reducing properties. Where the air temperature at the time of placement is expected to be consistently over 80 degrees F, a set retarding admixture such as Sika Chemical Corporation's Plastiment, Master Builder's Pozzolith 300R, or equal shall be used. Where the air temperature at the time of placement is expected to be consistently under 40 degrees F, a set accelerating admixture such as Sika Chemical Corporation's Plastocrete 161FL, Master Builder's Pozzolith 50C, or equal shall be used.
4. Low range water reducer shall conform to ASTM C494, Type A. It shall be either a hydroxylated carboxylic acid type or a hydroxylated polymer type. The quantity of admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations.
5. High range water reducer shall be sulfonated polymer conforming to ASTM C494, Type F or G:
  - a. If the high range water reducing agent is added to the concrete at the batch plant, it shall be second generation type, Daracem 100, as manufactured by W.R. Grace & Co.; [Pozzolith 430R, as manufactured by Masterbuilders; or equal. High range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified.
  - b. If the high range water reducer is added to the concrete at the job site, it shall be used in conjunction with a low range water reducer and shall be Pozzolith 400N and Pozzolith MBL82, as manufactured by Masterbuilders; WRDA 19 and WRDA 79, as manufactured by W.R. Grace & Co.; or equal. Concrete shall have a slump of 3-inches  $\pm$  1/2- inch prior to adding the high range water reducing admixture at the job site. The high range water reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the job site system.
6. Air-entraining agent meeting the requirements of ASTM C260, shall be used. Sufficient air-entraining agent shall be used to provide a total air content of 3 to 4 percent; provided that, when the mean daily temperature in the vicinity of the worksite falls below 40 degrees F for more than one day, the total air content provided shall be 5 to 6 percent. The Owner reserves the right, at any time, to sample and test the air-entraining agent received on the job by the Contractor. The air-entraining agent shall

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be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement.

7. Calcium Chloride: Except as otherwise provided herein, calcium chloride will not be permitted to be used in concrete.
  8. Fly ash/pozzolan shall conform to ASTM C618 and the following supplementary requirements:
    - a. Class F Fly Ash:
      - 1) Loss on ignition: maximum 4 percent.
      - 2) SO<sub>3</sub> content: maximum 3 percent.
      - 3) Moisture content: maximum 1 percent.
    - b. Class F fly ash, as a percent by weight of total cementitious material, shall not exceed 15 percent.
    - c. When Sulfate Resistant or Special Exposure Concrete is specified, test results shall be submitted to the Engineer as specified in Section 2-5.3 of the Standard Specifications. The test result shall show that the fly ash to be used is effective in contributing to sulfate resistance in conformance with ASTM C618, Table 3 (optional physical requirements) as tested in accordance with ASTM C1012. The data submitted shall be less than 6 months old.
- H. Curing Materials:
1. Concrete curing compound shall conform to the requirements of ASTM C309 Type 1 – clear or translucent without dye, except the loss of water shall not exceed 0.15 kilograms per square meter in 24 hours nor 0.45 kilograms per square meter in 72 hours when tested in accordance with ASTM C156. The Contractor shall provide, when requested by the Engineer, certified copies of vendor's test report showing compliance with ASTM C309 and these specifications. The testing and the report shall be supplied without cost to the Agency. All compounds shall be furnished by the Contractor in sealed original containers labeled in accordance with ASTM C309 and with the date of manufacture.
  2. Polyethylene sheet for use as concrete curing blanket shall be white and conform to ASTM C171. The loss of moisture when determined in accordance with the requirements of ASTM C156 shall not exceed 0.055 grams per square centimeter of surface.
  3. Polyethylene-coated burlap for use as concrete curing blanket shall conform to ASTM C171. The loss of moisture, when determined in accordance with the requirements of ASTM C156, shall not exceed 0.055 grams per square centimeter of surface.
- I. Expansion Joint Filler Material:
1. Curb & Gutter: Nonextruding and Resilient Filler: Celotex "Flexcell", or approved equal, 1/4-inch thick material conforming to ASTM D1751.
  2. Concrete Walk and Slab: Joint filler material shall be preformed expansion joint filler conforming to the requirements of ASTM D994. A Certificate of Compliance for the joint filler material shall be furnished to the Engineer. The certificate shall be accompanied with a certified test report of the results of the required tests performed on the joint filler material within the previous 12 months prior to proposed use. The certificate and accompanying test report shall be provided for each lot of joint filler material prior to use on the project.
  3. Silicone Joint Sealant - Premium-grade, high-performance, moisture-cured, single-component, polyurethane-based, non-sag elastomeric sealant. Meets Federal specification TT-S-00230C. Meets ASTM C920, Type S, Class 25 or 35; Grade NS, Use T or NT, Shore A Hardness (21 day) 35-45. A Certificate of Compliance for the silicone sealant shall be furnished to the Engineer. The Certificate shall also be accompanied with a certified test report of the results of the required tests performed on the sealant material within the previous 12 months prior to proposed use. The Certificate and accompanying test report shall be provided for each lot of silicone joint sealant prior to use on the project:



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- a. Sika Corporation, Sikaflex-1A.
  - b. Tremco, Inc., Dymonic.
  - c. Tremco, Inc., Vulkem 116.
  - d. Bostik Construction Products Div., Chem-Calk 900.
- J. Concrete Sealer: For natural color concrete only, HLQ-125 as manufactured by SINAK Corp., San Diego, CA (619/231-1771), HLQ-125 as manufactured by SINAK Corp., San Diego, CA (619/231-1771), or equivalent product of another manufacturer in accordance with the "or equal" provision of the Contract Documents, penetrating sealer that interacts with mineral compounds and siliceous materials in portland cement concrete to produce more dense, non-dusting surface.

## 2.2 CONCRETE MIX DESIGN

- A. Concrete Mix Design In Heavy Duty Areas - At a minimum, site concrete in heavy duty areas (as noted on grading plan) shall conform to the Standard Specifications for Public Works Construction, Section 201-1.1.2, mix class 650-CLE-4000P:
  - 1. Compressive Strength: Minimum of 4,000 psi at 28 days compressive strength.
  - 2. Slump Limit: 4 inches at point of placement.
  - 3. Cement per cu yard (sacks): 6.9 (minimum).
  - 4. Air Content: 4% +/- 1% percent.
  - 5. Verifiable Solar Reflectance: 0.30 (ASTM C1549).
- B. Concrete Mix Design In Light Duty Areas - At a minimum, site concrete in light duty areas (as noted on grading plan) shall conform to the Standard Specifications for Public Works Construction, Section 201-1.1.2, mix class 520-C-2500:
  - 1. Compressive Strength: Minimum of 2,500 psi at 28 days compressive strength.
  - 2. Slump Limit: 4 inches at point of placement.
  - 3. Cement per cu yard (sacks): 5.5 (minimum).
  - 4. Air Content: 4% +/- 1% percent.
  - 5. Verifiable Solar Reflectance: 0.30 (ASTM C1549)
- C. Slurry Mix Design:
  - 1. Compressive Strength: 100 psi at min. 28 days compressive strength.
  - 2. Slump Limit: 5 inches at point of placement.
  - 3. Cement per cu yard (sacks): 1.0
  - 4. Aggregate Gradation: "E" per S.S.P.W.C. table 201-1.3.2(A).
  - 5. Air Content: 4% +/- 1% percent.

## PART 3 EXECUTION

### 3.1 PREPARATION OF SURFACES FOR CONCRETING

- A. General: Earth surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.
- B. Aggregate base material shall be installed in layers not exceeding 4-inches and compacted to a minimum of 95% relative density.
- C. Subgrade Preparation:
  - 1. It is required that the native soil, and/or imported fill material, below the new aggregate base, be over excavated to the recommended minimum depth of 24 inches. Refer to section 13.2.2 of the soils report for recompaction requirements. The extent and depths

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- of removal should be evaluated by Geotechnical representative in the field based on the materials exposed. Additional removals may be recommended if loose or soft soils are exposed during grading.
2. Prior to placement of engineered fill, the subgrade shall be scarified to a depth of at least 8 inches, moisture conditioned and recompact to a minimum 90% relative density.
- D. The compacted surface shall be firm, hard and unyielding. The term "firm, hard and unyielding" as used in S.S.P.W.C. Section 301-1.3 shall mean that when the heaviest construction and hauling equipment used on the project drives over the subgrade, no permanent deformation shall occur either before or during pavement construction. On areas where the underlying material appears to be wet or soft, or where it deflects under wheel loads, the Contractor shall employ excavation and work techniques which do not worsen the subgrade condition.
  - E. The above subgrade preparation recommendations are based on the assumption that soils encountered during field exploration are representative of soils throughout the site. However, there can be unforeseen and unanticipated variations in soils between points of subsurface exploration. For this reason, the actual over-excavation depths will have to be determined on the basis of in-grading observations and testing performed by representatives of the project geotechnical consultant.
  - F. A California Licensed Surveyor (LS) must provide grade stakes and elevations for the Geotechnical Engineer to verify that any over-excavation depths, shown on the construction drawings for concrete pavement structural sections, have been achieved prior to re-compaction.
  - G. Joints in Concrete: Concrete surfaces upon or against which concrete is to be placed, where the placement of the old concrete has been stopped or interrupted so that, as determined by the Engineer, the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bond. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of all laitance, loose or defective concrete, and foreign material. Such cleaning shall be accomplished by sandblasting followed by thorough washing. All pools of water shall be removed from the surface of construction joints before the new concrete is placed.
  - H. Embedded Items: No concrete shall be placed until all formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the Inspector at least 24 hours before placement of concrete. All surfaces of forms and embedded items that have become encrusted with dried grout from concrete previously placed shall be cleaned of all such grout before the surrounding or adjacent concrete is placed.
  - I. All inserts or other embedded items shall conform to the requirements herein.
  - J. All reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms where shown or by shop drawings and shall be acceptable to the Inspector before any concrete is placed. Accuracy of placement is the responsibility of the Contractor.
  - K. Where concrete is to be cast against old concrete, (greater than 60 days of age), the surface of the old concrete shall be thoroughly cleaned and roughened by sand-blasting, exposing the aggregate. In concrete shear-walls, suspended slabs and roof slabs, the interface surface at construction joints shall be roughened to a full amplitude of one quarter inch. The hardened surface shall be cleaned of all latent foreign material and washed clean, prior to the application of an epoxy bonding agent.



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- L. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the work. No concrete shall be deposited underwater nor shall the Contractor allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, will be subject to the review of the Engineer.
- M. Corrosion Protection: Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2-inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.
- N. Openings for pipes, inserts for pipe hangers and brackets, and the setting of anchors shall, where practicable, be provided for during the placing of concrete.
- O. Anchor bolts shall be accurately set, and shall be maintained in position by templates while being embedded in concrete.
- P. Cleaning: The surfaces of all metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

### **3.2 HANDLING, TRANSPORTING, AND PLACING**

- A. General: Placing of concrete shall conform to the applicable requirements of ACI 301 and the requirements of this Section.
- B. The total elapsed time between the addition of water at the batch plant and the completion of the discharge of the concrete from the mixer shall not exceed 90 minutes. All concrete remaining in the mixer after said 90-minute time limit shall be rejected and removed from the project site.
- C. Non-Conforming Work or Materials: Concrete which upon or before placing is found not to conform to the requirements specified herein shall be rejected and immediately removed from the work. Concrete which is not placed in accordance with these Specifications, or which is of inferior quality, shall be removed and replaced by and at the expense of the Contractor.
- D. Whenever batch trucks or other paving equipment cause rutting of the subgrade or subbase in concrete placement areas, inspectors shall immediately stop construction. Construction shall not be allowed to resume until distorted subgrade or subbase is repaired. Contractors and inspectors should locate by proof rolling, any questionable unstable areas in advance to avoid distortion under equipment. Wet, unstable areas must be dried out or replaced before starting placement of asphalt. Locating wet or soft areas in advance can be accomplished by testing finished subgrade or subbase with a loaded truck. Construction of concrete pavement should not proceed unless testing gives a reasonable indication that distortions will not occur during construction of overlying pavement. When repair, aeration, and recompaction are required to correct damage from Contractor's operation, all necessary repair will be done at Contractor's expense. However, if the Engineer determines that additional depth of aeration and recompaction are needed, that should be paid by change order.

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- E. All pull boxes, meter boxes, valve covers and manholes shall be adjusted to proposed finish grade prior to placement of the concrete.
- F. Dowel Placement:
  - 1. Dowel bars shall be centered on the joint within a tolerance of  $\pm 2$  inches in the longitudinal direction directly over the contact joint or sawcut for the transverse weakened plane joints, as shown on the plans. Prior to placement of dowel bars, the Contractor shall submit to the Engineer a written procedure to identify the transverse weakened plane joint locations relative to the middle of the dowel bars and the procedure for consolidating concrete around the dowel bars.
  - 2. Dowel bars shall be placed at longitudinal joints as shown on the plans. Dowel bars shall be placed as shown on the plans by using mechanical insertion. When dowel bars are placed by mechanical insertion, the concrete over the dowel bars shall be reworked and refinished so that there is no evidence on the surface of the completed pavement that there has been any insertion performed. When drill and bonding of dowel bars is performed at contact joints, a grout retention ring shall be used.
- G. Concrete shall not be placed until the forms and reinforcement have been inspected, all preparations for the placement have been completed, and the preparations have been checked by the project inspector, all subject to the observation of the engineer or architect.
- H. Casting New Concrete Against Old: An approved epoxy adhesive bonding agent shall be applied to the old surfaces according to the manufacturer's written recommendations. This provision shall not apply to joints where waterstop is installed.
- I. Conveyor Belts and Chutes: All ends of chutes, hopper gates, and all other points of concrete discharge throughout the Contractor's conveying, hoisting and placing system shall be so designed and arranged that concrete passing from them will not fall separated into whatever receptacle immediately receives it. Conveyor belts, if used, shall be of a type acceptable to the Inspector. Chutes longer than 50 feet will not be permitted. Minimum slopes of chutes shall be such that concrete of the specified consistency will readily flow in them. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted. All conveyor belts and chutes shall be covered. Sufficient illumination shall be provided in the interior of all forms so that the concrete at the places of deposit is visible from the deck or runway.
- J. Placement in Slabs: Concrete placed in sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the pour. As the work progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.
- K. Temperature of Concrete: The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 40 degrees F in moderate weather, and not less than 50 degrees F in weather during which the mean daily temperature drops below 40 degrees F. Concrete ingredients shall not be heated to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, from falling below the specified minimum temperature. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, the Contractor shall employ effective means, such as precooling of aggregates and mixing water using ice or placing at night, as necessary to maintain the temperature of the concrete, as it is placed, below 90 degrees F. The Contractor shall be entitled to no additional compensation on account of the foregoing requirements.
- L. Cold Weather Placement: Earth foundations shall be free from frost or ice when concrete is placed upon or against them. Fly ash concrete shall not be placed when the air temperature falls below 50 degrees F.

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- M. A transverse construction joint shall be constructed, including dowel bars, at the end of each day's work or where concrete placement is interrupted for more than 30 minutes, to coincide with the next contraction joint location. If sufficient concrete has not been mixed to form a slab to match the next contraction joint, when an interruption occurs, the excess concrete shall be removed and disposed of back to the last preceding joint. The cost of removing and disposing of excess concrete shall be at the Contractor's expense. Excess material shall become the property of the Contractor and shall be disposed of. A metal or wooden bulkhead (header) shall be used to form the joint. The bulkhead shall be designed to accommodate the installation of dowel bars.
- N. Broom Finish Type:
1. Surfaces Sloped Less than 6%: Provide a medium salt (medium broom) finish by drawing a soft bristle broom across concrete surface, perpendicular to line of traffic, to provide a uniform fine line texture.
  2. Surfaces Sloped greater than 6%: Provide a slip resistant (heavy broom finish) by striating surface 1/16 inch to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.
  3. Joints in concrete curb, gutter, and walk shall be designated as expansion joints and control joints. Joints for concrete flatwork shall be provided every eight (8) feet or less. Expansion joints for swales, curbs / curb & gutter shall be placed at no greater than 24 feet on center or as indicated on construction drawings:
    - a. Expansion Joints - Provide 1/2" premolded joint filler, material meeting Section 2.01I herein. Construct expansion joints in conformance with Standard Specification Section 303-5.4.2 and the details on the construction documents:
      - 1) Extend expansion joint fillers full-width and depth of joint, and 1/4" below finished surface where joint filler is indicated. If no joint sealer is called for, place top of premolded joint filler flush with top of concrete or curb.
      - 2) Where silicone joint sealer is noted on the construction documents, the premolded joint filler strips shall be placed 1" below the surface of the concrete or curb, the full width of the expansion joint. The remainder of all joints shall be filled to within 1/4" below the surface of the concrete with the silicone joint sealant.
      - 3) Provide expansion joint filler strips, with elastomeric sealer, between p.c.c. walk and curb, p.c.c. walk and buildings, & p.c.c. walk and retaining walls and at locations noted on the construction documents. The depth of the filler strip shall be the depth of the p.c.c. walk plus 1 inch with the top set flush with the specified grade of the top of curb or walk.
    - b. Control Joints:
      - 1) Control joints in site work concrete shall comply with Standard Specification Section 302-6.5.4, except that the configuration of the joint, shall be as indicated on the construction documents.
      - 2) Control joints in concrete curbs, sidewalks and gutters shall comply with Standard Specification Section 303-5.4.3, except that the joint configuration shall be as indicated below.
      - 3) Location: As shown on construction documents, but in any case not more than eight (8) feet O.C. both ways in concrete sidewalks. In swales and gutters, including gutter integral with curb, joints shall be at regular intervals not exceeding five (5) feet. Where integral curb and gutter is adjacent to concrete pavement, the joint shall be aligned with the pavement joints where practical.
- O. Protection: In hot, dry, and windy weather protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control film. Apply according to manufacturer's instructions after screeding and bull floating, but before floating.

### 3.3 TAMPING AND VIBRATING

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- A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted, throughout the entire depth of the layer which is being consolidated, into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete during placement. Vibrators shall be high speed power vibrators (8000 to 10,000 rpm) of an immersion type in sufficient number and with (at least one) standby units as required.
- B. Care shall be used in placing concrete around waterstops. The concrete shall be carefully worked by rodding and vibrating to make sure that all air and rock pockets have been eliminated. Where flat-strip type waterstops are placed horizontally, the concrete shall be worked under the waterstops by hand, making sure that all air and rock pockets have been eliminated. Concrete surrounding the waterstops shall be given additional vibration, over and above that used for adjacent concrete placement to assure complete embedment of the waterstops in the concrete.
- C. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against all surfaces. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly as specified. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the results herein specified within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall be kept from contact with the surfaces of the forms. Care shall be taken not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

### 3.4 CURING

- A. Comply with 2019 California Building Code, Title 24, Part 2, Volume 2, Section 1905A.11:
  - 1. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least seven (7) days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.
- B. Curing Methods - Perform curing of concrete by curing as herein specified:
  - 1. Provide moisture-curing by the following methods:
    - a. Keep concrete surface continuously wet by covering with water.
    - b. Continuous water-fog spray.
    - c. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4 inch lap over adjacent absorptive covers.
  - 2. Provide curing and sealing compound to exposed exterior slabs, walks, and curbs, as follows:
    - a. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours). Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Re-coat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
    - b. Do not use membrane curing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid, floor hardener, waterproofing, dampproofing, membrane roofing, flooring (such as ceramic or quarry tile, glue-down carpet), painting, and other coatings and finish materials, unless otherwise acceptable to Architect.
- C. Concrete slabs and paving shall be properly cured and protected against damage and defacement of nature during construction operations. If weather is hot or surface has dried

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out, spray surface with fine mist of water starting not later than two hours after final troweling. Surface of finish shall be kept continuously wet for at least ten days. Wetting is considered emergency work and shall be performed on weekends and holidays if necessary.

- D. Concrete Sealer Application - Apply specified concrete sealer in continuous operation in accordance with manufacturer's instructions and recommendations:
  - 1. Prior to starting application, protect adjoining Work, including sealant bond surfaces, from spillage or blow-over of concrete sealer:
    - a. Cover adjoining and nearby surfaces of aluminum and glass where there is the possibility of the concrete sealer being deposited on surfaces.
    - b. Cover live plants and grass.
    - c. Immediately clean concrete sealer from adjoining surfaces, complying with manufacturer's cleaning recommendations.
  - 2. Apply concrete sealer under temperature conditions according to manufacturer's instructions.
  - 3. Apply concrete sealer in light, even coats using garden sprayer, airless sprayer or paint brush.
  - 4. Apply concrete sealer at rate to suit porosity of portland cement concrete but not less than no more than coverage rates recommended by manufacturer for effective sealing of surface.
- E. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the Owner. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at the Contractor's expense. Exclude traffic from concrete paving for at least 7 days after placement.
- F. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep concrete paving not more than 2 days prior to date scheduled for Substantial Completion inspections.

### 3.5 PUMPING OF CONCRETE

- A. General: If the pumped concrete does not produce satisfactory end results, the Contractor shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.
- B. Pumping Equipment: The pumping equipment must have 2 cylinders and be designed to operate with one cylinder only in case the other one is not functioning. In lieu of this requirement, the Contractor may have a standby pump on the site during pumping.
- C. The minimum diameter of the hose (conduits) shall be 4-inches.
- D. Pumping equipment and hoses (conduits) that are not functioning properly, shall be replaced.
- E. Aluminum conduits for conveying the concrete will not be permitted.
- F. Proportioning: Minimum compressive strength, cement content, and maximum size of aggregates shall be as specified herein.

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- G. Gradation of coarse aggregates shall conform to ASTM C33 and shall be as close to the middle range as possible.
- H. Gradation of fine aggregate shall conform to ASTM C33, with 15 to 30 percent passing the number 50 screen and 5 to 10 percent passing the number 100 screen. The fineness modulus of sand used shall not be over 3.00.
- I. Water and slump requirements shall conform to the requirements of this Section.
- J. Cement and admixtures shall conform to the requirements of this Section.
- K. Field Control: Concrete samples for slump per ASTM C143 and test cylinders per ASTM C31 and C39.

### 3.6 TREATMENT OF SURFACE DEFECTS

- A. As soon as forms are removed, all exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the Engineer. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall have them repaired as specified herein. Concrete containing extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced:
  - 1. All repairs and replacements herein specified shall be promptly executed by the Contractor at its own expense.
- B. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material, and not less than 1/32-inch depth of the surface film from all hard portions, by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces under repair will remain moist, but not so wet as to overcome the suction upon which a good bond depends. The material used for repair purposes shall consist of a mixture of one sack of cement to 3 cubic feet of sand. For exposed walls, the cement shall contain such a proportion of Atlas white portland cement as is required to make the color of the patch match the color of the surrounding concrete.
- C. Holes left by tie-rod cones shall be reamed so as to leave the surfaces of the holes clean and rough. These holes then shall be repaired in an approved manner with non-shrink grout. Holes left by form-tying devices having a rectangular cross-section, and other imperfections having a depth greater than their least surface dimension, shall not be reamed but shall be repaired in an approved manner with non-shrink grout.
- D. All repairs shall be built up and shaped in such a manner that the completed work will conform to the requirements of this Section, as applicable, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of said repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.
- E. Prior to filling any structure with water, all cracks that may have developed shall be repaired to the satisfaction of the Engineer. This repair method shall be done on the water bearing face of members. Prior to backfilling, faces of members in contact with fill, which are not



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covered with a waterproofing membrane, shall also have cracks repaired as specified herein.

- F. The finished surface shall be free from humps, sags, blemishes or other irregularities.

### **3.7 FIELD QUALITY CONTROL**

- A. Correction of Mix Design for Failed Concrete Tests: If the compressive cylinder strength test for in place PCC yields test results below the specified 28-day PCC compressive strength and the Engineer determines a corrective change is necessary, the Contractor shall, at its own expense, make corrective changes in the mix proportions. The Engineer shall approve the changes in the mix proportions or PCC placement procedures, before any additional PCC is placed on the job.
- B. Flood Tests: Before final acceptance, and after concrete has thoroughly cured, all concrete pavement, including swales and curb & gutter, shall be water tested to ensure proper drainage as directed by the Inspector. The Contractor shall provide water for this purpose. The flooding shall be done by water tank truck. Concrete work where water ponds and does not run off in a reasonable amount of time (1-hour), shall be removed to the nearest score or joint line and replaced to provide proper drainage. Full compensation for complying with this requirement shall be considered as included in the Contract Unit Price for cement concrete pavement.

### **3.8 CARE AND REPAIR OF CONCRETE**

- A. General: The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the Owner. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at the Contractor's expense.
- B. The contractor shall barricade and protect placed Portland Cement Concrete from all damage, marks, marks and/or graffiti. Any Portland Cement Concrete damaged, defaced, discolored or defective shall be replaced at the contractor's expense.

**END OF SECTION 32 13 13**