



**Sato ES Addition  
Beaverton School District  
Portland, Oregon**

**Project Manual  
Bid / Permit Set  
DLR Group Project No. 74-22109-00**

**June 10, 2022**

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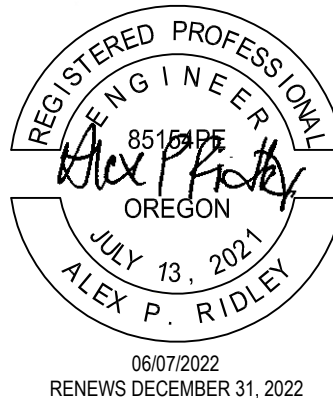
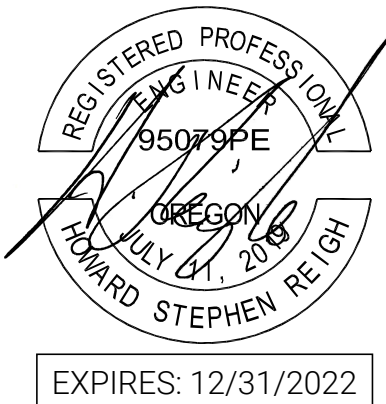
Project Manual

**Sato ES Addition  
Beaverton School District  
Portland, Oregon**

**DLR Group Project No. 74-22109-00**  
Combined Contract

June 10, 2022

Bid / Permit Set



**DLR Group Architecture & Engineering inc., an Oregon corporation**  
Architecture Engineering Planning Interiors  
110 SW Yamhill Street, Suite 105, Portland, OR 97204  
tel 503/274-2675 fax 503/274-0313

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SATO ES ADDITION  
BEAVERTON SCHOOL DISTRICT  
PORTLAND, OREGON

74-22109-00  
10 JUNE 2022  
BID / PERMIT SET

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## SECTION 011000 - 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:

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. Contractor-furnished, Owner-installed products.
10. Access to site.
11. Coordination with occupants.
12. Work restrictions.
13. Specification and Drawing conventions.
14. Miscellaneous provisions.

- B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

#### 1.3 PROJECT INFORMATION

- A. Project Identification: Sato Elementary School.

1. Project Location: 7775 NW Kaiser RD, Portland, OR 97229.

- B. Owner: Beaverton School District  
Owner's Representative: Doaa Elhaggan  
Construction Project Manager  
Facilities Development Department  
16550 SW Merlo Road  
Beaverton, OR 97003  
(503) 356-4364
- C. Architect: DLR Group
- D. Web-Based Project Software: Project software administered by Owner will be used for purposes of managing communication and documents during the construction stage.
  - 1. See Beaverton School District standards for requirements for using web-based Project software.

#### 1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following:
  - 1. 4,650 SF Renovation and 5,200 SF Addition to existing elementary school to be constructed of Type IIB fully sprinklered construction and other Work indicated in the Contract Documents.
- B. Type of Contract:
  - 1. Project will be constructed under a single prime contract (per AIA documents A101-2007 and A201-2007).

#### 1.5 WORK BY OWNER

- A. General: Cooperate fully with Owner so work may be carried out smoothly, without interfering with or delaying work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.

#### 1.6 OWNER-FURNISHED PRODUCTS

- A. Owner will furnish products indicated. The Work includes receiving, unloading, handling, storing, protecting, and installing Owner-furnished products and making building services connections.
- B. Owner-Furnished Products:
  - 1. As noted in Owner Furnished Material and Equipment Schedule in drawing set.

1.7 ACCESS TO SITE

- A. General: Contractor shall have access to the Project site during the construction period according to AIA201 3.13.

1.8 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
  - 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
  - 1. Notify Owner not less than two days in advance of proposed utility interruptions.
  - 2. Obtain Owner's written permission before proceeding with utility interruptions.
- C. Restricted Substances: Use of tobacco products and other controlled substances on Project site is not permitted.
- D. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.
- E. Employee Screening: Comply with Owner's requirements for screening of Contractor personnel working on Project site.
  - 1. Maintain list of approved screened personnel with Owner's representative.
  - 2. Badging to be provided by contractor.

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. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

- C. 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 published as part of the U.S. National CAD Standard and scheduled on Drawings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 011000

## SECTION 012500 - SUBSTITUTION PROCEDURES

### 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 administrative and procedural requirements for substitutions.
- B. Related Requirements:
  - 1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

#### 1.3 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
  - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
  - 2. Substitutions for Convenience: Changes proposed by Contractor that are not required in order to meet other Project requirements but may offer advantage to Contractor.

#### 1.4 ACTION SUBMITTALS

- A. Substitution Requests: Refer to AIA Document A201 in the Supplementary Conditions for consideration of requests received after Contract award. Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Substitution Request Form: Use facsimile of form provided in Project Manual.
  - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.

- b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
  - c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
  - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
  - e. Samples, where applicable or requested.
  - f. Certificates and qualification data, where applicable or requested.
  - g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
  - h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
  - i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
  - j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
  - k. Cost information, including a proposal of change, if any, in the Contract Sum.
  - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
  - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
  - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

## 1.5 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

## 1.6 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

## 1.7 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
  - 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
    - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    - b. Substitution request is fully documented and properly submitted.
    - c. Requested substitution will not adversely affect Contractor's construction schedule.
    - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
    - e. Requested substitution is compatible with other portions of the Work.
    - f. Requested substitution has been coordinated with other portions of the Work.
    - g. Requested substitution provides specified warranty.
    - h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION (NOT USED)

END OF SECTION 012500

## SUBSTITUTION PROCEDURES

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## SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract (AIA 201), including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Requirements:
  - 1. Section 012500 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

#### 1.3 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710 and eBuilder.

#### 1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
  - 1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
  - 2. Within 10 days after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
    - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    - c. Include costs of labor and supervision directly attributable to the change.

- d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
  - e. Quotation Form: Use forms acceptable to Architect.
- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.
  - 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
  - 2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
  - 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
  - 4. Include costs of labor and supervision directly attributable to the change.
  - 5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
  - 6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
  - 7. Proposal Request Form: Use form acceptable to Architect.

## 1.5 CHANGE ORDER PROCEDURES

- A. A Change Order is a written instrument prepared by the Architect, Owner or Contractor and signed by the Owner, Contractor and (at Owner's election) Architect stating their agreement upon all of the following:
  - 1. The change in the Work;
  - 2. The amount of the adjustment, if any, in the Contract Sum; and
  - 3. The extent of the adjustment, if any, in the Contract Time.
- B. Methods used in determining adjustments to the Contract Sum may include those listed in Section 7.3.3.
- C. Agreement on any Amendment shall constitute a final settlement of all matters relating to the change in the Work that is the subject of the Change Order, including, but not limited to, all direct and indirect costs associated with such change and any and all adjustments to the Contract Sum, the construction schedule, and the Contract Time.

## 1.6 CONSTRUCTION CHANGE DIRECTIVE

- A. A Construction Change Directive is a written order signed by the Owner (and at Owner's election, prepared and/or signed by Architect), directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both. The Owner may by Construction Change Directive, without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, the Contract Sum and Contract Time being adjusted accordingly.
- B. A Construction Change Directive shall be used in the absence of total agreement on the terms of a Change Order.
- C. Upon receipt of a Construction Change Directive, the Contractor shall promptly proceed with the change in the Work involved. As soon as possible, but no longer than seven days of receipt, the Contractor shall advise the Owner and the Architect of the Contractor's agreement or disagreement with the cost or the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum or Contract Time. If the Contractor does not timely disagree with the adjustments, the Construction Change Directive will be deemed an agreed "Change Order". The Contractor's notice shall reasonably specify the reasons for its disagreement and the amount or other terms that it proposes. Without such timely written notice, the Contractor shall conclusively be deemed to have accepted the Owner's adjustment. The Contractor's disagreement shall not relieve the Contractor its obligation to comply promptly with any written notice issued by the Owner or the Architect. The adjustment shall then be determined by the Owner on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, in strict accordance with this Paragraph and other applicable provisions of the Contract Documents.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION (NOT USED)

END OF SECTION 012600

## SECTION 012900 - PAYMENT PROCEDURES

### 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 administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
  - 1. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
  - 2. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

#### 1.3 DEFINITIONS

- A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

#### 1.4 SCHEDULE OF VALUES

- A. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
  - 1. Identification: Include the following Project identification on the schedule of values:
    - a. Project name and location.
    - b. Name of Architect.
    - c. Architect's Project number.
    - d. Contractor's name and address.
    - e. Date of submittal.
  - 2. Arrange the schedule of values in tabular form, with separate columns to indicate the following for each item listed:

- a. Related Specification Section or Division.
  - b. Description of the Work.
  - c. Name of subcontractor.
  - d. Name of manufacturer or fabricator.
  - e. Name of supplier.
  - f. Change Orders (numbers) that affect value.
  - g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent. Round dollar amounts to whole dollars, with total equal to Contract Sum.
    - 1) Labor.
    - 2) Materials.
    - 3) Equipment.
3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
4. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
  - a. Differentiate between items stored on-site and items stored off-site.
5. Overhead Costs: Include total cost and proportionate share of general overhead and profit for each line item.
6. Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
7. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

## 1.5 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
- C. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
  1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.

## PAYMENT PROCEDURES

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2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
  3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
  4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.
- D. Transmittal: Submit signed and notarized original copies of each Application for Payment to Architect through Owner's web-based program (eBuilder).
- E. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
  2. Schedule of values.
  3. Contractor's construction schedule (preliminary if not final).
  4. Products list (preliminary if not final).
  5. Sustainable design action plans, including preliminary project materials cost data.
  6. Schedule of unit prices.
  7. Submittal schedule (preliminary if not final).
  8. List of Contractor's staff assignments.
  9. List of Contractor's principal consultants.
  10. Copies of building permits.
  11. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
  12. Initial progress report.
  13. Report of preconstruction conference.
- F. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
  2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
  3. Contractor shall provide all requirements of documents AIA 201 Section 9.10.2.
- G. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
  2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
  3. Updated final statement, accounting for final changes to the Contract Sum.
  4. All listed items in AIA Document A201 Section 9.10.2.

SATO ES ADDITION  
BEAVERTON SCHOOL DISTRICT  
PORTLAND, OREGON

74-22109-00  
10 JUNE 2022  
BID / PERMIT SET

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 012900

PAYMENT PROCEDURES

012900 - 4

## SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

### 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 administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
  - 1. General coordination procedures.
  - 2. Coordination drawings.
  - 3. RFIs.
  - 4. Digital project management procedures.
  - 5. Project meetings.
- B. Related Requirements:
  - 1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
  - 2. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.
  - 3. Section 019113 "General Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

#### 1.3 DEFINITIONS

- A. BIM: Building Information Modeling.
- B. RFI: Request for Information. Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
  - 1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.

2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Provide organizational chart and chain of command. Identify individuals and their duties and responsibilities; list addresses and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office, in web-based Project software directory, and in prominent location in built facility. Keep list current at all times.

## 1.5 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Pre-installation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

## 1.6 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
    - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
    - b. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
    - c. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
    - d. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
    - e. Indicate required installation sequences.
    - f. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Organize coordination drawings as follows:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
  2. Plenum Space: Indicate sub-framing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
  3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
  4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
  5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
  6. Mechanical and Plumbing Work: Show the following:

- a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
    - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
    - c. Fire-rated enclosures around ductwork.
  7. Electrical Work: Show the following:
    - a. Runs of vertical and horizontal conduit 1-1/4 inches (32 mm) in diameter and larger.
    - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
    - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor-control center locations.
    - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
  8. Fire-Protection System: Show the following:
    - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
  9. Review: Architect will review coordination drawings to confirm that in general the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.
  10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
  2. File Preparation Format: DWG, Version, operating in Microsoft Windows operating system.
  3. File Submittal Format: Submit or post coordination drawing files using PDF format.
  4. BIM File Incorporation: Develop and incorporate coordination drawing files into BIM established for Project.
    - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect.
  5. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.

- a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
  - b. Digital Data Software Program: Drawings are available in BIM.
  - c. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Architect.
6. Allow up to 14 working days for review by owner and architect.

## 1.7 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
  2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
  2. Project number.
  3. Date.
  4. Name of Contractor.
  5. Name of Architect.
  6. RFI number, numbered sequentially.
  7. RFI subject.
  8. Specification Section number and title and related paragraphs, as appropriate.
  9. Drawing number and detail references, as appropriate.
  10. Field dimensions and conditions, as appropriate.
  11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
  12. Contractor's signature.
  13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
    - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.
1. Attachments shall be electronic files in PDF format.
  2. RFIs will be submitted through owner provided web-based program (eBuilder).

- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
    - a. Requests for approval of submittals.
    - b. Requests for approval of substitutions.
    - c. Requests for approval of Contractor's means and methods.
    - d. Requests for coordination information already indicated in the Contract Documents.
    - e. Requests for adjustments in the Contract Time or the Contract Sum.
    - f. Requests for interpretation of Architect's actions on submittals.
    - g. Incomplete RFIs or inaccurately prepared RFIs.
  2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect of additional information.
  3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
    - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Use software log that is part of web-based Project software. Software log with not less than the following:
1. Project name.
  2. Name and address of Contractor.
  3. Name and address of Architect.
  4. RFI number including RFIs that were returned without action or withdrawn.
  5. RFI description.
  6. Date the RFI was submitted.
  7. Date Architect's response was received.
  8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
- F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Contractor disagrees with response.

## 1.8 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Use of Architect's Digital Data Files: Digital data files of Architect's BIM model will be provided by Architect for Contractor's use during construction.
  - 1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project record Drawings.
  - 2. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
  - 3. Digital Drawing Software Program: Contract Drawings are available in BIM (Revit).
  - 4. Contractor shall execute a data licensing agreement in the form of AIA Document C106 Digital Data Licensing Agreement.
    - a. Sub-contractors, and other parties granted access by Contractor to Architect's digital data files shall execute a data licensing agreement in the form of AIA Document C106.
- B. Web-Based Project Software: Use Owner's web-based Project software site for purposes of hosting and managing Project communication and documentation until Final Completion.
- C. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:
  - 1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
  - 2. Name file with submittal number or other unique identifier, including revision identifier.
  - 3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

## 1.9 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
  - 1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times a minimum of 10 working days prior to meeting.
  - 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
  - 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.
- B. Preconstruction Conference: Schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.

1. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
  2. Agenda: Discuss items of significance that could affect progress, including the following:
    - a. Responsibilities and personnel assignments.
    - b. Tentative construction schedule.
    - c. Phasing.
    - d. Critical work sequencing and long lead items.
    - e. Designation of key personnel and their duties.
    - f. Lines of communications.
    - g. Use of web-based Project software.
    - h. Procedures for processing field decisions and Change Orders.
    - i. Procedures for RFIs.
    - j. Procedures for testing and inspecting.
    - k. Procedures for processing Applications for Payment.
    - l. Distribution of the Contract Documents.
    - m. Submittal procedures.
    - n. Preparation of Record Documents.
    - o. Use of the premises.
    - p. Work restrictions.
    - q. Working hours.
    - r. Owner's occupancy requirements.
    - s. Responsibility for temporary facilities and controls.
    - t. Procedures for moisture and mold control.
    - u. Procedures for disruptions and shutdowns.
    - v. Construction waste management and recycling.
    - w. Parking availability.
    - x. Office, work, and storage areas.
    - y. Equipment deliveries and priorities.
    - z. First aid.
    - aa. Security.
  3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Pre-installation Conferences: Conduct a pre-installation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Owner's Commissioning Authority of scheduled meeting dates.
  2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

- a. Contract Documents.
  - b. Options.
  - c. Related RFIs.
  - d. Related Change Orders.
  - e. Purchases.
  - f. Deliveries.
  - g. Submittals.
  - h. Sustainable design requirements.
  - i. Review of mockups.
  - j. Possible conflicts.
  - k. Compatibility requirements.
  - l. Time schedules.
  - m. Weather limitations.
  - n. Manufacturer's written instructions.
  - o. Warranty requirements.
  - p. Compatibility of materials.
  - q. Acceptability of substrates.
  - r. Temporary facilities and controls.
  - s. Space and access limitations.
  - t. Regulations of authorities having jurisdiction.
  - u. Testing and inspecting requirements.
  - v. Installation procedures.
  - w. Coordination with other work.
  - x. Required performance results.
  - y. Protection of adjacent work.
  - z. Protection of construction and personnel.
3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
  4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
  5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
  2. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
  3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

- a. Preparation of Record Documents.
  - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
  - c. Procedures for completing and archiving web-based Project software site data files.
  - d. Submittal of written warranties.
  - e. Requirements for preparing operations and maintenance data.
  - f. Requirements for delivery of material samples, attic stock, and spare parts.
  - g. Requirements for demonstration and training.
  - h. Preparation of Contractor's punch list.
  - i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
  - j. Submittal procedures.
  - k. Owner's partial occupancy requirements.
  - l. Installation of Owner's furniture, fixtures, and equipment.
  - m. Responsibility for removing temporary facilities and controls.
4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Progress Meetings: Conduct progress meetings at weekly intervals.
1. Coordinate dates of meetings with preparation of payment requests.
  2. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
  3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
    - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
      - 1) Review schedule for next period.
    - b. Review present and future needs of each entity present, including the following:
      - 1) Interface requirements.
      - 2) Sequence of operations.
      - 3) Status of submittals.
      - 4) Deliveries.
      - 5) Off-site fabrication.
      - 6) Access.

- 7) Site use.
  - 8) Temporary facilities and controls.
  - 9) Progress cleaning.
  - 10) Quality and work standards.
  - 11) Status of correction of deficient items.
  - 12) Field observations.
  - 13) Status of RFIs.
  - 14) Status of Proposal Requests.
  - 15) Pending changes.
  - 16) Status of Change Orders.
  - 17) Pending claims and disputes.
  - 18) Documentation of information for payment requests.
4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
- a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 013100

## SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

### 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.
- B. AIA Document A201, Section 3.10

#### 1.2 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
  - 1. Startup construction schedule.
  - 2. Contractor's Construction Schedule.
  - 3. Construction schedule updating reports.
  - 4. Daily construction reports.
  - 5. Material location reports.
  - 6. Site condition reports.
  - 7. Unusual event reports.

#### 1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.
  - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
  - 2. Predecessor Activity: An activity that precedes another activity in the network.
  - 3. Successor Activity: An activity that follows another activity in the network.
- B. Float: The measure of leeway in starting and completing an activity.
  - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
  - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.

- 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- C. Resource Loading: The allocation of manpower and equipment necessary for completing an activity as scheduled.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
  - 1. Working electronic copy of schedule file, where indicated.
  - 2. PDF file.
- B. Startup construction schedule.
  - 1. Submittal of cost-loaded, startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.
- C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
  - 1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.
- D. Construction Schedule Updating Reports: Submit with Applications for Payment.
- E. Daily Construction Reports: Submit at monthly intervals.
- F. Material Location Reports: Submit at monthly intervals.
- G. Site Condition Reports: Submit at time of discovery of differing conditions.
- H. Unusual Event Reports: Submit at time of unusual event.
- I. Qualification Data: For scheduling consultant.

#### 1.5 QUALITY ASSURANCE

- A. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's Construction Schedule, including, but not limited to, the following:
  - 1. Review software limitations and content and format for reports.
  - 2. Verify availability of qualified personnel needed to develop and update schedule.
  - 3. Discuss constraints, including phasing work stages area separations and interim milestones.

4. Review delivery dates for Owner-furnished products.
5. Review submittal requirements and procedures.
6. Review time required for review of submittals and resubmittals.
7. Review requirements for tests and inspections by independent testing and inspecting agencies.
8. Review time required for Project closeout and Owner startup procedures, including commissioning activities.
9. Review and finalize list of construction activities to be included in schedule.
10. Review procedures for updating schedule.

#### 1.6 COORDINATION

- A. Coordinate Contractor's Construction Schedule with the submittal schedule, progress reports, payment requests, and other required schedules and reports.
  1. Secure time commitments for performing critical elements of the Work from entities involved.
  2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

#### 1.7 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
  1. Use Scheduling component of Project website software specified in Section 013100 "Project Management and Coordination," or other approved software available to owner and architect for current Windows operating system.
- B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of final completion.
  1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
  1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
  2. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.

3. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
  4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
  5. Commissioning Time: Include no fewer than 15 days for commissioning.
  6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
  7. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.
- D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
  2. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
  3. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
  4. Work Restrictions: Show the effect of the following items on the schedule:
    - a. Coordination with existing construction.
    - b. Uninterruptible services.
    - c. Use-of-premises restrictions.
    - d. Provisions for future construction.
    - e. Seasonal variations.
    - f. Environmental control.
- E. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
1. See Section 012900 "Payment Procedures" for cost reporting and payment procedures.
- F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
1. Unresolved issues.
  2. Unanswered Requests for Information.
  3. Rejected or unreturned submittals.
  4. Notations on returned submittals.
  5. Pending modifications affecting the Work and the Contract Time.

- G. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
  - 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
  - 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
  - 3. As the Work progresses, indicate final completion percentage for each activity.
- H. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.
- I. Distribution: Distribute copies of approved schedule to Architect Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
  - 1. Post copies in Project meeting rooms and temporary field offices.
  - 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

## 1.8 STARTUP CONSTRUCTION SCHEDULE

- A. Gantt-Chart Schedule: Submit startup, horizontal, Gantt-chart-type construction schedule within seven days of date established for the Notice to Proceed.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

## 1.9 GANTT-CHART SCHEDULE REQUIREMENTS

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for commencement of the Work.
  - 1. Base schedule on the startup construction schedule and additional information received since the start of Project.

- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

#### 1.10 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
  2. List of separate contractors at Project site.
  3. Approximate count of personnel at Project site.
  4. Equipment at Project site.
  5. Material deliveries.
  6. High and low temperatures and general weather conditions, including presence of rain or snow.
  7. Testing and inspection.
  8. Accidents.
  9. Meetings and significant decisions.
  10. Unusual events.
  11. Stoppages, delays, shortages, and losses.
  12. Meter readings and similar recordings.
  13. Emergency procedures.
  14. Orders and requests of authorities having jurisdiction.
  15. Change Orders received and implemented.
  16. Construction Change Directives received and implemented.
  17. Services connected and disconnected.
  18. Equipment or system tests and startups.
  19. Partial completions and occupancies.
  20. Substantial Completions authorized.
- B. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.
- C. Unusual Event Reports: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.
1. Submit unusual event reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

SATO ES ADDITION  
BEAVERTON SCHOOL DISTRICT  
PORTLAND, OREGON

74-22109-00  
10 JUNE 2022  
BID / PERMIT SET

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 013200

CONSTRUCTION PROGRESS DOCUMENTATION

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## SECTION 013300 - SUBMITTAL PROCEDURES

### 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.
- B. AIA Document A201, Section 3.12

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Submittal schedule requirements.
  - 2. Administrative and procedural requirements for submittals.
- B. Related Requirements:
  - 1. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
  - 2. Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
  - 3. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
  - 4. Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
  - 5. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
  - 6. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
  - 7. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
  - 8. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

#### 1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

#### 1.4 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.
1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
  2. Initial Submittal: Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
  3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
    - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
  4. Format: Arrange the following information in a tabular format:
    - a. Scheduled date for first submittal.
    - b. Specification Section number and title.
    - c. Submittal Category: Action; informational.
    - d. Name of subcontractor.
    - e. Description of the Work covered.
    - f. Scheduled date for Architect's final release or approval.

#### 1.5 SUBMITTAL FORMATS

- A. Submittal Information: Include the following information in each submittal:
1. Project name.
  2. Date.
  3. Name of Architect.
  4. Name of Contractor.
  5. Name of firm or entity that prepared submittal.
  6. Names of subcontractor, manufacturer, and supplier.
  7. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
  8. Category and type of submittal.

9. Submittal purpose and description.
  10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
  11. Drawing number and detail references, as appropriate.
  12. Location(s) where product is to be installed, as appropriate.
  13. Other necessary identification.
  14. Remarks.
  15. Signature of transmitter.
- B. Options: Identify options requiring selection by Architect.
- C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- D. PDF Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.
- E. Submittals for Web-Based Project Software: Prepare submittals as PDF files, or other format indicated by Project software website.

## 1.6 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Email: Prepare submittals as PDF package, and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.
    - a. Architect will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.
  2. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.

3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
  4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections so processing will not be delayed because of need to review submittals concurrently for coordination.
    - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 14 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
  2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
  3. Resubmittal Review: Allow 14 days for review of each resubmittal.
  4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 14 days for initial review of each submittal.
  5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow 14 days for review of each submittal. Submittal will be returned to Architect before being returned to Contractor.
    - a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect and Construction Manager.
- D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
  2. Note date and content of revision in label or title block and clearly indicate extent of revision.
  3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

## 1.7 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
  2. Mark each copy of each submittal to show which products and options are applicable.
  3. Include the following information, as applicable:
    - a. Manufacturer's catalog cuts.
    - b. Manufacturer's product specifications.
    - c. Standard color charts.
    - d. Statement of compliance with specified referenced standards.
    - e. Testing by recognized testing agency.
    - f. Application of testing agency labels and seals.
    - g. Notation of coordination requirements.
    - h. Availability and delivery time information.
  4. For equipment, include the following in addition to the above, as applicable:
    - a. Wiring diagrams that show factory-installed wiring.
    - b. Printed performance curves.
    - c. Operational range diagrams.
    - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
  5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - a. Identification of products.
    - b. Schedules.
    - c. Compliance with specified standards.
    - d. Notation of coordination requirements.
    - e. Notation of dimensions established by field measurement.
    - f. Relationship and attachment to adjoining construction clearly indicated.
    - g. Seal and signature of professional engineer if specified.
- C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.

## SUBMITTAL PROCEDURES

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2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
    - a. Project name and submittal number.
    - b. Generic description of Sample.
    - c. Product name and name of manufacturer.
    - d. Sample source.
    - e. Number and title of applicable Specification Section.
    - f. Specification paragraph number and generic name of each item.
  3. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
  4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
    - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
    - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
  5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
    - a. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record Sample.
      - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
      - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
  2. Manufacturer and product name, and model number if applicable.
  3. Number and name of room or space.
  4. Location within room or space.
- E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- G. Certificates:
1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
  2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
  3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
  4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
  5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
  6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- H. Test and Research Reports:
1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
  2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
  3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
  - a. Name of evaluation organization.
  - b. Date of evaluation.
  - c. Time period when report is in effect.
  - d. Product and manufacturers' names.
  - e. Description of product.
  - f. Test procedures and results.
  - g. Limitations of use.

#### 1.8 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file and three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
  1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

#### 1.9 CONTRACTOR'S REVIEW

- A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

- B. Contractor's Approval: Indicate Contractor's approval for each submittal with indication in web-based Project software. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

#### 1.10 ARCHITECT'S REVIEW

- A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required.
1. PDF Submittals: Architect will indicate, via markup on each submittal, the appropriate action.
  2. Submittals by Web-Based Project Software: Architect will indicate, on Project software website, the appropriate action.
- B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- C. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- D. Architect will return without review submittals received from sources other than Contractor.
- E. Submittals not required by the Contract Documents will be returned by Architect without action.

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

#### PART 3 - EXECUTION (NOT USED)

END OF SECTION 013300

## SECTION 014000 - QUALITY REQUIREMENTS

### 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 administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
  - 1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
  - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
  - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, Commissioning Authority, or authorities having jurisdiction are not limited by provisions of this Section.
  - 4. Specific test and inspection requirements are not specified in this Section.

#### 1.3 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
  - D. Mockups: Full-size physical assemblies that are constructed on-site either as freestanding temporary built elements or as part of permanent construction. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
    1. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as freestanding temporary built elements or as part of permanent construction, consisting of multiple products, assemblies, and subassemblies.
  - E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
  - F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
  - G. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.
  - H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
  - I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
  - J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect or Construction Manager.
- 1.4 DELEGATED-DESIGN SERVICES
- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

#### 1.5 CONFLICTING REQUIREMENTS

- A. **Conflicting Standards and Other Requirements:** If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for direction before proceeding.
- B. **Minimum Quantity or Quality Levels:** The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

#### 1.6 ACTION SUBMITTALS

- A. **Shop Drawings:** For integrated exterior mockups.
  1. Include plans, sections, and elevations, indicating materials and size of mockup construction.
  2. Indicate manufacturer and model number of individual components.
  3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.
- B. **Delegated-Design Services Submittal:** In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. **Contractor's Quality-Control Plan:** For quality-assurance and quality-control activities and responsibilities.
- B. **Qualification Data:** For Contractor's quality-control personnel.
- C. **Contractor's Statement of Responsibility:** When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
  2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
1. Specification Section number and title.
  2. Entity responsible for performing tests and inspections.
  3. Description of test and inspection.
  4. Identification of applicable standards.
  5. Identification of test and inspection methods.
  6. Number of tests and inspections required.
  7. Time schedule or time span for tests and inspections.
  8. Requirements for obtaining samples.
  9. Unique characteristics of each quality-control service.
- F. Reports: Prepare and submit certified written reports and documents as specified.
- G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.
- 1.8 CONTRACTOR'S QUALITY-CONTROL PLAN
- A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's Construction Schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
1. Project quality-control manager may also serve as Project superintendent.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
1. Contractor-performed tests and inspections including Subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
  2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections will be conducted by Owner.
  3. Owner-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by Commissioning Authority.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

## 1.9 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
1. Date of issue.
  2. Project title and number.
  3. Name, address, telephone number, and email address of testing agency.
  4. Dates and locations of samples and tests or inspections.
  5. Names of individuals making tests and inspections.
  6. Description of the Work and test and inspection method.
  7. Identification of product and Specification Section.
  8. Complete test or inspection data.
  9. Test and inspection results and an interpretation of test results.
  10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
  11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
  12. Name and signature of laboratory inspector.
  13. Recommendations on retesting and re-inspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of technical representative making report.
  2. Statement on condition of substrates and their acceptability for installation of product.
  3. Statement that products at Project site comply with requirements.
  4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
  5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  6. Statement whether conditions, products, and installation will affect warranty.
  7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of factory-authorized service representative making report.
  2. Statement that equipment complies with requirements.
  3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  4. Statement whether conditions, products, and installation will affect warranty.
  5. Other required items indicated in individual Specification Sections.

#### 1.10 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or products which are similar in material, design, and extent to those indicated for this Project.

- F. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- G. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
  - 1. Contractor responsibilities include the following:
    - a. Provide test specimens representative of proposed products and construction.
    - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
    - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
    - d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
    - e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
    - f. When testing is complete, remove test specimens and test assemblies, and mockups; do not reuse products on Project.
  - 2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect and Commissioning Authority, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
  - 1. Build mockups of size indicated.
  - 2. Build mockups in location indicated or, if not indicated, as directed by Architect.
  - 3. Notify Architect seven days in advance of dates and times when mockups will be constructed.

4. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed to perform same tasks during the construction at Project.
  5. Demonstrate the proposed range of aesthetic effects and workmanship.
  6. Obtain Architect's approval of mockups before starting corresponding work, fabrication, or construction.
    - a. Allow seven days for initial review and each re-review of each mockup.
  7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
- K. Integrated Exterior Mockups: Construct integrated exterior mockup according to approved Shop Drawings. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials. Comply with requirements in "Mockups" Paragraph.

#### 1.11 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
  2. Payment for these services will be made from testing and inspection allowances, as authorized by Change Orders.
  3. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
  2. Engage a qualified testing agency to perform quality-control services.
    - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
  3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
  4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
  5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.

6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Retesting/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- D. Testing Agency Responsibilities: Cooperate with Architect, Commissioning Authority and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect, Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
  2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
  3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
  4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
  5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
  6. Do not perform duties of Contractor.
- E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."
- F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in pre-installation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- G. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
  2. Incidental labor and facilities necessary to facilitate tests and inspections.
  3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
  4. Facilities for storage and field curing of test samples.
  5. Delivery of samples to testing agencies.
  6. Preliminary design mix proposed for use for material mixes that require control by testing agency.

7. Security and protection for samples and for testing and inspection equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
  1. Schedule times for tests, inspections, obtaining samples, and similar activities.

#### 1.12 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Conducted by a qualified testing agency or special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:
  1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
  2. Notifying Architect, Commissioning Authority, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
  3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect and Commissioning Authority with copy to Contractor and to authorities having jurisdiction.
  4. Submitting a final report of special tests and inspections at Substantial Completion, that includes a list of unresolved deficiencies.
  5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
  6. Retesting and re-inspecting corrected work.

### PART 2 - PRODUCTS (NOT USED)

### PART 3 - EXECUTION

#### 3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
  1. Date test or inspection was conducted.
  2. Description of the Work tested or inspected.
  3. Date test or inspection results were transmitted to Architect.
  4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's, Commissioning Authority's, reference during normal working hours.

### QUALITY REQUIREMENTS

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1. Submit log at Project closeout as part of Project Record Documents.

END OF SECTION 014000

## SECTION 014200 - REFERENCES

### 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 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

#### 1.3 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if

## REFERENCES

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bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

#### 1.4 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. AABC - Associated Air Balance Council; [www.aabc.com](http://www.aabc.com).
2. AAMA - American Architectural Manufacturers Association; [www.aamanet.org](http://www.aamanet.org).
3. AAPFCO - Association of American Plant Food Control Officials; [www.aapfco.org](http://www.aapfco.org).
4. AASHTO - American Association of State Highway and Transportation Officials; [www.transportation.org](http://www.transportation.org).
5. AATCC - American Association of Textile Chemists and Colorists; [www.aatcc.org](http://www.aatcc.org).
6. ABMA - American Bearing Manufacturers Association; [www.americanbearings.org](http://www.americanbearings.org).
7. ABMA - American Boiler Manufacturers Association; [www.abma.com](http://www.abma.com).
8. ACI - American Concrete Institute; (Formerly: ACI International); [www.abma.com](http://www.abma.com).
9. ACPA - American Concrete Pipe Association; [www.concrete-pipe.org](http://www.concrete-pipe.org).
10. AEIC - Association of Edison Illuminating Companies, Inc. (The); [www.aeic.org](http://www.aeic.org).
11. AF&PA - American Forest & Paper Association; [www.afandpa.org](http://www.afandpa.org).
12. AGA - American Gas Association; [www.aga.org](http://www.aga.org).
13. AHAM - Association of Home Appliance Manufacturers; [www.aham.org](http://www.aham.org).
14. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); [www.ahrinet.org](http://www.ahrinet.org).
15. AI - Asphalt Institute; [www.asphaltinstitute.org](http://www.asphaltinstitute.org).
16. AIA - American Institute of Architects (The); [www.aia.org](http://www.aia.org).
17. AISC - American Institute of Steel Construction; [www.aisc.org](http://www.aisc.org).
18. AISI - American Iron and Steel Institute; [www.steel.org](http://www.steel.org).
19. AITC - American Institute of Timber Construction; [www.aitc-glulam.org](http://www.aitc-glulam.org).
20. AMCA - Air Movement and Control Association International, Inc.; [www.amca.org](http://www.amca.org).
21. ANSI - American National Standards Institute; [www.ansi.org](http://www.ansi.org).
22. AOSA - Association of Official Seed Analysts, Inc.; [www.aosaseed.com](http://www.aosaseed.com).
23. APA - APA - The Engineered Wood Association; [www.apawood.org](http://www.apawood.org).
24. APA - Architectural Precast Association; [www.archprecast.org](http://www.archprecast.org).
25. API - American Petroleum Institute; [www.api.org](http://www.api.org).
26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
27. ARI - American Refrigeration Institute; (See AHRI).
28. ARMA - Asphalt Roofing Manufacturers Association; [www.asphaltroofing.org](http://www.asphaltroofing.org).
29. ASCE - American Society of Civil Engineers; [www.asce.org](http://www.asce.org).
30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
31. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; [www.ashrae.org](http://www.ashrae.org).

32. ASME - ASME International; (American Society of Mechanical Engineers); [www.asme.org](http://www.asme.org).
33. ASSE - American Society of Safety Engineers (The); [www.asse.org](http://www.asse.org).
34. ASSE - American Society of Sanitary Engineering; [www.asse-plumbing.org](http://www.asse-plumbing.org).
35. ASTM - ASTM International; [www.astm.org](http://www.astm.org).
36. ATIS - Alliance for Telecommunications Industry Solutions; [www.atis.org](http://www.atis.org).
37. AWEA - American Wind Energy Association; [www.awea.org](http://www.awea.org).
38. AWI - Architectural Woodwork Institute; [www.awinet.org](http://www.awinet.org).
39. AWMAC - Architectural Woodwork Manufacturers Association of Canada; [www.awmac.com](http://www.awmac.com).
40. AWPA - American Wood Protection Association; [www.awpa.com](http://www.awpa.com).
41. AWS - American Welding Society; [www.aws.org](http://www.aws.org).
42. AWWA - American Water Works Association; [www.awwa.org](http://www.awwa.org).
43. BHMA - Builders Hardware Manufacturers Association; [www.buildershardware.com](http://www.buildershardware.com).
44. BIA - Brick Industry Association (The); [www.gobrick.com](http://www.gobrick.com).
45. BICSI - BICSI, Inc.; [www.bicsi.org](http://www.bicsi.org).
46. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); [www.bifma.org](http://www.bifma.org).
47. BISSC - Baking Industry Sanitation Standards Committee; [www.bissc.org](http://www.bissc.org).
48. BWF - Badminton World Federation; (Formerly: International Badminton Federation); [www.bissc.org](http://www.bissc.org).
49. CDA - Copper Development Association; [www.copper.org](http://www.copper.org).
50. CEA - Canadian Electricity Association; [www.electricity.ca](http://www.electricity.ca).
51. CEA - Consumer Electronics Association; [www.ce.org](http://www.ce.org).
52. CFFA - Chemical Fabrics and Film Association, Inc.; [www.chemicalfabricsandfilm.com](http://www.chemicalfabricsandfilm.com).
53. CFSEI - Cold-Formed Steel Engineers Institute; [www.cfsei.org](http://www.cfsei.org).
54. CGA - Compressed Gas Association; [www.cganet.com](http://www.cganet.com).
55. CIMA - Cellulose Insulation Manufacturers Association; [www.cellulose.org](http://www.cellulose.org).
56. CISCA - Ceilings & Interior Systems Construction Association; [www.cisca.org](http://www.cisca.org).
57. CISPI - Cast Iron Soil Pipe Institute; [www.cispi.org](http://www.cispi.org).
58. CLFMI - Chain Link Fence Manufacturers Institute; [www.chainlinkinfo.org](http://www.chainlinkinfo.org).
59. CPA - Composite Panel Association; [www.pbmdf.com](http://www.pbmdf.com).
60. CRI - Carpet and Rug Institute (The); [www.carpet-rug.org](http://www.carpet-rug.org).
61. CRRC - Cool Roof Rating Council; [www.coolroofs.org](http://www.coolroofs.org).
62. CRSI - Concrete Reinforcing Steel Institute; [www.crsi.org](http://www.crsi.org).
63. CSA - Canadian Standards Association; [www.csa.ca](http://www.csa.ca).
64. CSA - CSA International; (Formerly: IAS - International Approval Services); [www.csa-international.org](http://www.csa-international.org).
65. CSI - Construction Specifications Institute (The); [www.csinet.org](http://www.csinet.org).
66. CSSB - Cedar Shake & Shingle Bureau; [www.cedarbureau.org](http://www.cedarbureau.org).
67. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); [www.cti.org](http://www.cti.org).
68. CWC - Composite Wood Council; (See CPA).
69. DASMA - Door and Access Systems Manufacturers Association; [www.dasma.com](http://www.dasma.com).
70. DHI - Door and Hardware Institute; [www.dhi.org](http://www.dhi.org).
71. ECA - Electronic Components Association; (See ECIA).
72. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
73. ECIA - Electronic Components Industry Association; [www.eciaonline.org](http://www.eciaonline.org).
74. EIA - Electronic Industries Alliance; (See TIA).

## REFERENCES

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75. EIMA - EIFS Industry Members Association; [www.eima.com](http://www.eima.com).
76. EJMA - Expansion Joint Manufacturers Association, Inc.; [www.ejma.org](http://www.ejma.org).
77. ESD - ESD Association; (Electrostatic Discharge Association); [www.esda.org](http://www.esda.org).
78. ESTA - Entertainment Services and Technology Association; (See PLASA).
79. EVO - Efficiency Valuation Organization; [www.evo-world.org](http://www.evo-world.org).
80. FCI - Fluid Controls Institute; [www.fluidcontrolsinstitute.org](http://www.fluidcontrolsinstitute.org).
81. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); [www.fiba.com](http://www.fiba.com).
82. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); [www.fivb.org](http://www.fivb.org).
83. FM Approvals - FM Approvals LLC; [www.fmglobal.com](http://www.fmglobal.com).
84. FM Global - FM Global; (Formerly: FMG - FM Global); [www.fmglobal.com](http://www.fmglobal.com).
85. FRSA - Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.; [www.floridarooft.com](http://www.floridarooft.com).
86. FSA - Fluid Sealing Association; [www.fluidsealing.com](http://www.fluidsealing.com).
87. FSC - Forest Stewardship Council U.S.; [www.fscus.org](http://www.fscus.org).
88. GA - Gypsum Association; [www.gypsum.org](http://www.gypsum.org).
89. GANA - Glass Association of North America; [www.glasswebsite.com](http://www.glasswebsite.com).
90. GS - Green Seal; [www.greenseal.org](http://www.greenseal.org).
91. HI - Hydraulic Institute; [www.pumps.org](http://www.pumps.org).
92. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
93. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
94. HPVA - Hardwood Plywood & Veneer Association; [www.hpva.org](http://www.hpva.org).
95. HPW - H. P. White Laboratory, Inc.; [www.hpwhite.com](http://www.hpwhite.com).
96. IAPSC - International Association of Professional Security Consultants; [www.iapsc.org](http://www.iapsc.org).
97. IAS - International Accreditation Service; [www.iasonline.org](http://www.iasonline.org).
98. IAS - International Approval Services; (See CSA).
99. ICBO - International Conference of Building Officials; (See ICC).
100. ICC - International Code Council; [www.iccsafe.org](http://www.iccsafe.org).
101. ICEA - Insulated Cable Engineers Association, Inc.; [www.icea.net](http://www.icea.net).
102. ICPA - International Cast Polymer Alliance; [www.icpa-hq.org](http://www.icpa-hq.org).
103. ICRI - International Concrete Repair Institute, Inc.; [www.icri.org](http://www.icri.org).
104. IEC - International Electrotechnical Commission; <http://www.iec.ch>.
105. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); [www.ieee.org](http://www.ieee.org).
106. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); [www.ies.org](http://www.ies.org).
107. IESNA - Illuminating Engineering Society of North America; (See IES).
108. IEST - Institute of Environmental Sciences and Technology; [www.iest.org](http://www.iest.org).
109. IGMA - Insulating Glass Manufacturers Alliance; [www.igmaonline.org](http://www.igmaonline.org).
110. IGSHPA - International Ground Source Heat Pump Association; [www.igshpa.okstate.edu](http://www.igshpa.okstate.edu).
111. ILI - Indiana Limestone Institute of America, Inc.; [www.iliai.com](http://www.iliai.com).
112. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); [www.intertek.com](http://www.intertek.com).
113. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); [www.isa.org](http://www.isa.org).
114. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).

## REFERENCES

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115. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); [www.isfanow.org](http://www.isfanow.org).
116. ISO - International Organization for Standardization; [www.iso.org](http://www.iso.org).
117. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
118. ITU - International Telecommunication Union; [www.itu.int/home](http://www.itu.int/home).
119. KCMA - Kitchen Cabinet Manufacturers Association; [www.kcma.org](http://www.kcma.org).
120. LMA - Laminating Materials Association; (See CPA).
121. LPI - Lightning Protection Institute; [www.lightning.org](http://www.lightning.org).
122. MBMA - Metal Building Manufacturers Association; [www.mbma.com](http://www.mbma.com).
123. MCA - Metal Construction Association; [www.metalconstruction.org](http://www.metalconstruction.org).
124. MFMA - Maple Flooring Manufacturers Association, Inc.; [www.maplefloor.org](http://www.maplefloor.org).
125. MFMA - Metal Framing Manufacturers Association, Inc.; [www.metalframingmfg.org](http://www.metalframingmfg.org).
126. MHIA - Material Handling Industry of America; [www.mhia.org](http://www.mhia.org).
127. MIA - Marble Institute of America; [www.marble-institute.com](http://www.marble-institute.com).
128. MMPA - Moulding & Millwork Producers Association; [www.wmmpa.com](http://www.wmmpa.com).
129. MPI - Master Painters Institute; [www.paintinfo.com](http://www.paintinfo.com).
130. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; [www.mss-hq.org](http://www.mss-hq.org).
131. NAAMM - National Association of Architectural Metal Manufacturers; [www.naamm.org](http://www.naamm.org).
132. NACE - NACE International; (National Association of Corrosion Engineers International); [www.nace.org](http://www.nace.org).
133. NADCA - National Air Duct Cleaners Association; [www.nadca.com](http://www.nadca.com).
134. NAIMA - North American Insulation Manufacturers Association; [www.naima.org](http://www.naima.org).
135. NBGQA - National Building Granite Quarries Association, Inc.; [www.nbgqa.com](http://www.nbgqa.com).
136. NBI - New Buildings Institute; [www.newbuildings.org](http://www.newbuildings.org).
137. NCAA - National Collegiate Athletic Association (The); [www.ncaa.org](http://www.ncaa.org).
138. NCMA - National Concrete Masonry Association; [www.ncma.org](http://www.ncma.org).
139. NEBB - National Environmental Balancing Bureau; [www.nebb.org](http://www.nebb.org).
140. NECA - National Electrical Contractors Association; [www.necanet.org](http://www.necanet.org).
141. NeLMA - Northeastern Lumber Manufacturers Association; [www.nelma.org](http://www.nelma.org).
142. NEMA - National Electrical Manufacturers Association; [www.nema.org](http://www.nema.org).
143. NETA - InterNational Electrical Testing Association; [www.netaworld.org](http://www.netaworld.org).
144. NFHS - National Federation of State High School Associations; [www.nfhs.org](http://www.nfhs.org).
145. NFPA - National Fire Protection Association; [www.nfpa.org](http://www.nfpa.org).
146. NFPA - NFPA International; (See NFPA).
147. NFRC - National Fenestration Rating Council; [www.nfrc.org](http://www.nfrc.org).
148. NHLA - National Hardwood Lumber Association; [www.nhla.com](http://www.nhla.com).
149. NLGA - National Lumber Grades Authority; [www.nlga.org](http://www.nlga.org).
150. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
151. NOMMA - National Ornamental & Miscellaneous Metals Association; [www.nomma.org](http://www.nomma.org).
152. NRCA - National Roofing Contractors Association; [www.nrca.net](http://www.nrca.net).
153. NRMCA - National Ready Mixed Concrete Association; [www.nrmca.org](http://www.nrmca.org).
154. NSF - NSF International; [www.nsf.org](http://www.nsf.org).
155. NSPE - National Society of Professional Engineers; [www.nspe.org](http://www.nspe.org).
156. NSSGA - National Stone, Sand & Gravel Association; [www.nssga.org](http://www.nssga.org).
157. NTMA - National Terrazzo & Mosaic Association, Inc. (The); [www.ntma.com](http://www.ntma.com).
158. NWFA - National Wood Flooring Association; [www.nwfa.org](http://www.nwfa.org).

## REFERENCES

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159. PCI - Precast/Prestressed Concrete Institute; [www.pci.org](http://www.pci.org).
160. PDI - Plumbing & Drainage Institute; [www.pdionline.org](http://www.pdionline.org).
161. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); [www.plasa.org](http://www.plasa.org).
162. RCSC - Research Council on Structural Connections; [www.boltcouncil.org](http://www.boltcouncil.org).
163. RFCI - Resilient Floor Covering Institute; [www.rfci.com](http://www.rfci.com).
164. RIS - Redwood Inspection Service; [www.redwoodinspection.com](http://www.redwoodinspection.com).
165. SAE - SAE International; [www.sae.org](http://www.sae.org).
166. SCTE - Society of Cable Telecommunications Engineers; [www.scte.org](http://www.scte.org).
167. SDI - Steel Deck Institute; [www.sdi.org](http://www.sdi.org).
168. SDI - Steel Door Institute; [www.steeldoor.org](http://www.steeldoor.org).
169. SEFA - Scientific Equipment and Furniture Association (The); [www.sefalabs.com](http://www.sefalabs.com).
170. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
171. SIA - Security Industry Association; [www.siaonline.org](http://www.siaonline.org).
172. SJI - Steel Joist Institute; [www.steeljoist.org](http://www.steeljoist.org).
173. SMA - Screen Manufacturers Association; [www.smainfo.org](http://www.smainfo.org).
174. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; [www.smacna.org](http://www.smacna.org).
175. SMPTE - Society of Motion Picture and Television Engineers; [www.smpte.org](http://www.smpte.org).
176. SPFA - Spray Polyurethane Foam Alliance; [www.sprayfoam.org](http://www.sprayfoam.org).
177. SPIB - Southern Pine Inspection Bureau; [www.spib.org](http://www.spib.org).
178. SPRI - Single Ply Roofing Industry; [www.spri.org](http://www.spri.org).
179. SRCC - Solar Rating & Certification Corporation; [www.solar-rating.org](http://www.solar-rating.org).
180. SSINA - Specialty Steel Industry of North America; [www.ssina.com](http://www.ssina.com).
181. SSPC - SSPC: The Society for Protective Coatings; [www.sspc.org](http://www.sspc.org).
182. STI - Steel Tank Institute; [www.steeltank.com](http://www.steeltank.com).
183. SWI - Steel Window Institute; [www.steelwindows.com](http://www.steelwindows.com).
184. SWPA - Submersible Wastewater Pump Association; [www.swpa.org](http://www.swpa.org).
185. TCA - Tilt-Up Concrete Association; [www.tilt-up.org](http://www.tilt-up.org).
186. TCNA - Tile Council of North America, Inc.; [www.tileusa.com](http://www.tileusa.com).
187. TEMA - Tubular Exchanger Manufacturers Association, Inc.; [www.tema.org](http://www.tema.org).
188. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); [www.tiaonline.org](http://www.tiaonline.org).
189. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
190. TMS - The Masonry Society; [www.masonrysociety.org](http://www.masonrysociety.org).
191. TPI - Truss Plate Institute; [www.tpinst.org](http://www.tpinst.org).
192. TPI - Turfgrass Producers International; [www.turfgrasssod.org](http://www.turfgrasssod.org).
193. TRI - Tile Roofing Institute; [www.tilerroofing.org](http://www.tilerroofing.org).
194. UL - Underwriters Laboratories Inc.; [www.ul.com](http://www.ul.com).
195. UNI - Uni-Bell PVC Pipe Association; [www.uni-bell.org](http://www.uni-bell.org).
196. USAV - USA Volleyball; [www.usavolleyball.org](http://www.usavolleyball.org).
197. USGBC - U.S. Green Building Council; [www.usgbc.org](http://www.usgbc.org).
198. USITT - United States Institute for Theatre Technology, Inc.; [www.usitt.org](http://www.usitt.org).
199. WASTEC - Waste Equipment Technology Association; [www.wastec.org](http://www.wastec.org).
200. WCLIB - West Coast Lumber Inspection Bureau; [www.wclib.org](http://www.wclib.org).

## REFERENCES

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201. WCMA - Window Covering Manufacturers Association; [www.wcmanet.org](http://www.wcmanet.org).
202. WDMA - Window & Door Manufacturers Association; [www.wdma.com](http://www.wdma.com).
203. WI - Woodwork Institute; [www.wicnet.org](http://www.wicnet.org).
204. WSRCA - Western States Roofing Contractors Association; [www.wsrca.com](http://www.wsrca.com).
205. WWPA - Western Wood Products Association; [www.wwpa.org](http://www.wwpa.org).

B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

1. DIN - Deutsches Institut für Normung e.V.; [www.din.de](http://www.din.de).
2. IAPMO - International Association of Plumbing and Mechanical Officials; [www.iapmo.org](http://www.iapmo.org).
3. ICC - International Code Council; [www.iccsafe.org](http://www.iccsafe.org).
4. ICC-ES - ICC Evaluation Service, LLC; [www.icc-es.org](http://www.icc-es.org).

C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.

1. COE - Army Corps of Engineers; [www.usace.army.mil](http://www.usace.army.mil).
2. CPSC - Consumer Product Safety Commission; [www.cpsc.gov](http://www.cpsc.gov).
3. DOC - Department of Commerce; National Institute of Standards and Technology; [www.nist.gov](http://www.nist.gov).
4. DOD - Department of Defense; [www.quicksearch.dla.mil](http://www.quicksearch.dla.mil).
5. DOE - Department of Energy; [www.energy.gov](http://www.energy.gov).
6. EPA - Environmental Protection Agency; [www.epa.gov](http://www.epa.gov).
7. FAA - Federal Aviation Administration; [www.faa.gov](http://www.faa.gov).
8. FG - Federal Government Publications; [www.gpo.gov/fdsys](http://www.gpo.gov/fdsys).
9. GSA - General Services Administration; [www.gsa.gov](http://www.gsa.gov).
10. HUD - Department of Housing and Urban Development; [www.hud.gov](http://www.hud.gov).
11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; [www.eetd.lbl.gov](http://www.eetd.lbl.gov).
12. OSHA - Occupational Safety & Health Administration; [www.osha.gov](http://www.osha.gov).
13. SD - Department of State; [www.state.gov](http://www.state.gov).
14. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; [www.trb.org](http://www.trb.org).
15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; [www.ars.usda.gov](http://www.ars.usda.gov).
16. USDA - Department of Agriculture; Rural Utilities Service; [www.usda.gov](http://www.usda.gov).
17. USDOJ - Department of Justice; Office of Justice Programs; National Institute of Justice; [www.ojp.usdoj.gov](http://www.ojp.usdoj.gov).
18. USP - U.S. Pharmacopeial Convention; [www.usp.org](http://www.usp.org).
19. USPS - United States Postal Service; [www.usps.com](http://www.usps.com).

D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and

regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from Government Printing Office; [www.gpo.gov/fdsys](http://www.gpo.gov/fdsys).
2. DOD - Department of Defense; Military Specifications and Standards; Available from DLA Document Services; [www.quicksearch.dla.mil](http://www.quicksearch.dla.mil).
3. DSCC - Defense Supply Center Columbus; (See FS).
4. FED-STD - Federal Standard; (See FS).
5. FS - Federal Specification; Available from DLA Document Services; [www.quicksearch.dla.mil](http://www.quicksearch.dla.mil).
  - a. Available from Defense Standardization Program; [www.dsp.dla.mil](http://www.dsp.dla.mil).
  - b. Available from General Services Administration; [www.gsa.gov](http://www.gsa.gov).
  - c. Available from National Institute of Building Sciences/Whole Building Design Guide; [www.wbdg.org/ccb](http://www.wbdg.org/ccb).
6. MILSPEC - Military Specification and Standards; (See DOD).
7. USAB - United States Access Board; [www.access-board.gov](http://www.access-board.gov).
8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 014200

## SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

### 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 temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
  - 1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

#### 1.3 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, testing agencies, and authorities having jurisdiction.
- A. Sewer Service: Pay sewer-service use charges for sewer usage by all entities for construction operations.
- B. Water Service: Pay water-service use charges for water used by all entities for construction operations.
- C. Electric Power Service: Pay electric-power-service use charges for electricity used by all entities for construction operations.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
- B. Implementation and Termination Schedule: Within 15 days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.

## TEMPORARY FACILITIES AND CONTROLS

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- C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- D. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold.

## 1.5 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

## 1.6 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Portable Chain-Link Fencing: Minimum 2-inch (50-mm), 0.148-inch- (3.8-mm-) thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized-steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top and bottom rails. Provide concrete bases for supporting posts.
- B. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain link fence, sized to height of fence.

### 2.2 TEMPORARY FACILITIES

- A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:

## TEMPORARY FACILITIES AND CONTROLS

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1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
  2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- (1.2-m-) square tack and marker boards.
  3. Drinking water and private toilet.
  4. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
  5. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.
- C. Field Office, Owner: Prefabricated or mobile units of minimum size at least 10'x32'. Furnish and equip offices as follows:
1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
  2. Drinking water and private toilet.
  3. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
  4. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.
- D. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
1. Store combustible materials apart from building.

## 2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
  2. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction. and clean HVAC system as required in Section 017700 "Closeout Procedures."
- C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

## PART 3 - EXECUTION

### 3.1 TEMPORARY FACILITIES, GENERAL

- A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
  - 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

### 3.2 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

### 3.3 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
  - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
  - 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction as needed.
- D. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use as available.
- E. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

- F. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.
- G. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
1. Install electric power service underground, unless overhead service must be used.
  2. Where power distribution wiring is required by circumstances to be overhead, arrange it to rise vertically where least exposed to damage.
  3. Connect temporary service to new electrical transformer as directed by electric company officials.
- H. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- I. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install WiFi cell phone access equipment and one land-based telephone line(s) for each field office.
- J. Electronic Communication Service: Provide temporary electronic communication service, including electronic mail and internet access, in common-use facilities.
1. The Contractor shall provide an e-mail account for the duration of the project, commencing from the time job site offices are established to post final completion. All communication to be via email or the Owner's eBuilder site. Faxes will not be accepted.
  2. Provide the following infrastructure for the computer to be used by the Owner, Architect/Engineers.
    - a. An RJ45 wall jack on the near location when the computer is to be set, connected to:
    - b. A network device that has the capability, such as a router, which has the capability to issue a DHCP address to the computer that we will be using at that site.
    - c. The network device (router) should also have the ability to connect the computer that we will be using at that site to the internet.
    - d. An RJ 45 cable to connect from the RJ45 wall jack to the computer that we will be using at that site.

### 3.4 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Locate field offices, storage sheds, sanitary facilities, and other temporary construction and support facilities for easy access. Contractor's temporary facility locations shall be sited to provide the least disturbance possible to neighboring properties – Owner reserves the right to direct the location of temporary facilities like job-site trailers or temporary toilets.
2. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
3. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
4. Combustible structures should not be within 30 feet of trees or power poles.

B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.

1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.

C. Temporary Use of Planned Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
2. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Division 31.
3. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion.

D. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.

E. Parking: Provide temporary parking areas for construction personnel.

F. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
  2. Remove snow and ice as required to minimize accumulations.
- G. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
1. Identification Signs: Provide Project identification signs as indicated on Drawings.
  2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
    - a. Provide temporary, directional signs for construction personnel and visitors.
  3. Maintain and touch up signs so they are legible at all times.
- H. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- I. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- J. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- K. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

### 3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- C. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

- D. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.
  - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
  - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel.
- E. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.
- F. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- G. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
  - 1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- H. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
  - 1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
  - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
  - 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
  - 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

### 3.6 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture-Protection Plan: Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
  - 1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
  - 2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these

- operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
3. Indicate methods to be used to avoid trapping water in finished work.
- B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
1. Protect porous materials from water damage.
  2. Protect stored and installed material from flowing or standing water.
  3. Keep porous and organic materials from coming into prolonged contact with concrete.
  4. Remove standing water from decks.
  5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
  2. Keep interior spaces reasonably clean and protected from water damage.
  3. Periodically collect and remove waste containing cellulose or other organic matter.
  4. Discard or replace water-damaged material.
  5. Do not install material that is wet.
  6. Discard and replace stored or installed material that begins to grow mold.
  7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.
- D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
  2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
  3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
    - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective and require replacing.
    - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
    - c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within 48 hours.

### 3.7 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
  - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
  - 1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
  - 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
  - 3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

## SECTION 016000 - PRODUCT REQUIREMENTS

### 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 administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
  - 1. Section 012500 "Substitution Procedures" for requests for substitutions.
  - 2. Section 014200 "References" for applicable industry standards for products specified.

#### 1.3 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
  - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
  - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
  - 3. Comparable Product: Product that is demonstrated and approved by Architect through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual

characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.

- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications. Submit a comparable product request, if applicable.

#### 1.4 ACTION SUBMITTALS

- A. Comparable Product Request Submittal: Submit request for consideration of each comparable product. Identify basis-of-design product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
  - 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
    - a. Form of Architect's Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
    - b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

#### 1.5 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
- B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
  - 1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.

#### PRODUCT REQUIREMENTS

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2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
  - a. Name of product and manufacturer.
  - b. Model and serial number.
  - c. Capacity.
  - d. Speed.
  - e. Ratings.
3. See individual identification sections in Divisions 21, 22, 23, and 26 for additional identification requirements.

#### 1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
  1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
  2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
  3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
  4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
  1. Store products to allow for inspection and measurement of quantity or counting of units.
  2. Store materials in a manner that will not endanger Project structure.
  3. Store products that are subject to damage by the elements, under cover in a weather-tight enclosure above ground, with ventilation adequate to prevent condensation.
  4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
  5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
  6. Protect stored products from damage and liquids from freezing.
  7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

## 1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
  - 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
  - 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
  - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
  - 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
  - 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

## PART 2 - PRODUCTS

### 2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
  - 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  - 3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
  - 4. Where products are accompanied by the term "as selected," Architect will make selection.
  - 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. Product Selection Procedures:

## PRODUCT REQUIREMENTS

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1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
  - a. Sole product may be indicated by the phrase: "Subject to compliance with requirements, provide the following: ..."
2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
  - a. Sole manufacturer/source may be indicated by the phrase: "Subject to compliance with requirements, provide products by the following: ..."
3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
  - a. Limited list of products may be indicated by the phrase: "Subject to compliance with requirements, provide one of the following: ..."
4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, which complies with requirements.
  - a. Non-limited list of products is indicated by the phrase: "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following: ..."
5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
  - a. Limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, provide products by one of the following: ..."
6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, which complies with requirements.
  - a. Non-limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following: ..."

7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
  - a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.
- C. Visual Matching Specification: Where Specifications require "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
  1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

## 2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
  1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
  2. Evidence that proposed product provides specified warranty.
  3. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
  4. Samples, if requested.
- B. Submittal Requirements: Approval by the Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

SATO ES ADDITION  
BEAVERTON SCHOOL DISTRICT  
PORTLAND, OREGON

74-22109-00  
10 JUNE 2022  
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PART 3 - EXECUTION (NOT USED)

END OF SECTION 016000

PRODUCT REQUIREMENTS

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## SECTION 017300 - EXECUTION

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:
  - 1. Construction layout.
  - 2. Installation of the Work.
  - 3. Cutting and patching.
  - 4. Protection of installed construction.
  - 5. Correction of the Work.
- B. Related Requirements:
  - 1. Section 011000 "Summary"
  - 2. Section 013300 "Submittal Procedures" for submitting surveys.
  - 3. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.
  - 4. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.

#### 1.2 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.
- B. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
  - 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.

2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
3. Products: List products to be used for patching and firms or entities that will perform patching work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
  - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Final Property Survey: Submit digital copy showing the Work performed and record survey data.

#### 1.5 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. Professional Engineer Qualifications: Refer to Section 014000 "Quality Requirements."
- C. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
  1. Structural Elements: When cutting and patching structural elements, or when encountering the need for cutting and patching of elements whose structural function is not known, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
  2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
  3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety
  4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner

that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

- D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Comply with requirements specified in other Sections.
  - 1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with sustainable design requirements.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
  - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials. Use materials that are not considered hazardous.
- C. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
  - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
  - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where

## EXECUTION

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indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
1. Description of the Work, including Specification Section number and paragraph, and Drawing sheet number and detail, where applicable.
  2. List of detrimental conditions, including substrates.
  3. List of unacceptable installation tolerances.
  4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect.

### 3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Architect promptly.

- B. Engage a professional engineer experienced in laying out the Work, using the following accepted surveying practices:
  - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
  - 2. Establish limits on use of Project site.
  - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
  - 4. Inform installers of lines and levels to which they must comply.
  - 5. Check the location, level and plumb, of every major element as the Work progresses.
  - 6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
  - 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

### 3.4 INSTALLATION

- A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - 1. Make vertical work plumb, and make horizontal work level.
  - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
  - 4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces, unless otherwise indicated on Drawings.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure satisfactory results as judged by Architect. Maintain conditions required for product performance until Substantial Completion.

- D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.
- F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.
  - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
  - 2. Allow for building movement, including thermal expansion and contraction.
  - 3. Coordinate installation of anchorages. 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.
- I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Architect. Fit exposed connections together to form hairline joints.

### 3.5 CUTTING AND PATCHING

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
  - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of Work to be cut.

- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching in accordance with requirements in Section 011000 "Summary."
- F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.
- G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
  - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  - 3. Concrete: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  - 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
  - 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  - 6. Proceed with patching after construction operations requiring cutting are complete.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by Architect. Provide materials and comply with installation requirements specified in other Sections, where applicable.
  - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
  - 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
    - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    - b. Restore damaged pipe covering to its original condition.
  - 3. Floors and Walls: Where walls or partitions that are removed 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 in-place floor and wall

coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

- a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch, corner to corner of wall and edge to edge of ceiling. Provide additional coats until patch blends with adjacent surfaces.
4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

### 3.6 PROGRESS CLEANING

- A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
  1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
  2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
  3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
    - a. Use containers intended for holding waste materials of type to be stored.
  4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
  1. Remove liquid spills promptly.
  2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls." Section 017419 "Construction Waste Management and Disposal."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

### 3.7 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

### 3.8 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

- B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.
- C. Comply with manufacturer's written instructions for temperature and relative humidity.

### 3.9 CORRECTION OF THE WORK

- A. Repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates and finishes.
  - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.
- C. Restore permanent facilities used during construction to their specified condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 017300

## SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

### 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 administrative and procedural requirements for the following:
  - 1. Recycling nonhazardous demolition and construction waste.
  - 2. Disposing of nonhazardous demolition and construction waste.

#### 1.3 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

#### 1.4 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 30 days of date established for commencement of the Work.
- B. Reports: Submit monthly documentation to Owner with each Application for Payment prior to Substantial Completion substantiating that Waste Management Plan was maintained and that goals were achieved.
  - 1. Trash: Quantity by weight deposited in landfills. Include associated fees, transportation costs, container rentals, and taxes for total cost of disposal.

2. Salvaged Material: Quantity by weight or quantity with destination for each type of material salvaged for resale, recycling, or adaptive reuse. Include associated fees, transportation costs, container rentals, and taxes for total cost of disposal. Also, include reimbursements due to salvage resale.
3. Total Cost: Indicate total cost or savings for implementation of Waste Management Plan. This does not imply reimbursement by Owner.

## 1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

## 1.6 WASTE MANAGEMENT PLAN

- A. Waste Management Plan: Include the following information
  1. Analysis of the trash and waste projected to be generated during the entire project construction cycle, including types and quantities.
  2. Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of, the applicable landfill tipping fee(s), and the projected cost of disposing of all project trash/waste in the landfill(s).
  3. Landfill Alternatives: List all waste materials that will be diverted from landfills by reuse, salvage, or recycling.
  4. Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
  5. Materials Handling Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by designated facilities; include separation procedures for recyclables, storage, and packaging.
  6. Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

## CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

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1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."
- B. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
  1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
  2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

### 3.2 RECYCLING

- A. A. Use Source Separation Method or Co-mingling Method suitable to sorting and processing method of selected recycling center. Dispose non-recyclable trash separately into landfill.
  1. Source Separation Method: Recyclable materials separated from trash and sorted into bins or containers prior to transportation to recycling center.
  2. Co-Mingling Method: Recyclable materials separated from trash and placed in unsorted bins or container for sorting at recycling center.
- B. Materials suggested for recycling include:
  1. Packing materials including paper, cardboard, foam plastic, and sheeting.
  2. Recyclable plastics.
  3. Organic plant debris.
  4. Earth materials.
  5. Native stone and granular fill.
  6. Asphalt and paving.
  7. Wood.
  8. Glass.
  9. Metals.
  10. Gypsum products.
  11. Acoustical ceiling tile.
  12. Carpet.
  13. Equipment oil.

### 3.3 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
  1. Contractor will be responsible for disposing of any equipment in the existing buildings not scheduled to be salvaged to the owner.

2. Contractor will be responsible for disposing of remaining school portable units if present.
  3. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
  4. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.
- C. Burying: Do not bury waste materials.
- D. Disposal: Remove waste materials and dispose of at designated spoil areas on Owner's property.
- E. Disposal: Remove waste materials from Owner's property and legally dispose of them.

END OF SECTION 017419

## SECTION 017700 - CLOSEOUT PROCEDURES

### 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 administrative and procedural requirements for contract closeout, including, but not limited to, the following:
  - 1. Substantial Completion procedures.
  - 2. Final completion procedures.
  - 3. Warranties.
  - 4. Final cleaning.
  - 5. Repair of the Work.
- B. Related Requirements:
  - 1. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
  - 2. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
  - 3. Section 017900 "Demonstration and Training" for requirements to train the Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cleaning agent.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at final completion.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.

## CLOSEOUT PROCEDURES

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- C. Field Report: For pest control inspection.

## 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

## 1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
  2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, damage or settlement surveys, property surveys, Closeout Submittal Log, and similar final record information.
  3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
  4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number.
    - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Owner's signature for receipt of submittals.
  5. Submit testing, adjusting, and balancing records.
  6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Advise Owner of pending insurance changeover requirements.
  2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.

## CLOSEOUT PROCEDURES

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3. Complete startup and testing of systems and equipment.
4. Perform preventive maintenance on equipment used prior to Substantial Completion.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
6. Advise Owner of changeover in utility services.
7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
9. Complete final cleaning requirements.
10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for final completion.

## 1.7 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment according to Section 012900 "Payment Procedures."
2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report.
5. Submit final completion photographic documentation.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

## CLOSEOUT PROCEDURES

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1. Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

#### 1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
  1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
  2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
  3. Include the following information at the top of each page:
    - a. Project name.
    - b. Date.
    - c. Name of Architect.
    - d. Name of Contractor.
    - e. Page number.
  4. Submit list of incomplete items in the following format:
    - a. MS Excel electronic file. Architect will return annotated file.
    - b. Web-based project software upload. Utilize software feature for creating and updating list of incomplete items (punch list).

#### 1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- D. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
  1. Submit by uploading to web-based project software site.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

## PART 3 - EXECUTION

### 3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
  - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
    - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
    - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    - c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
    - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
    - e. Remove snow and ice to provide safe access to building.
    - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
    - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
    - h. Sweep concrete floors broom clean in unoccupied spaces.
    - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
    - j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.

## CLOSEOUT PROCEDURES

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- k. Remove labels that are not permanent.
  - l. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
  - m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
  - n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
  - o. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
  - p. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
  - q. Leave Project clean and ready for occupancy.
- C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.
- D. Construction Waste Disposal: Comply with Owner waste disposal.

### 3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair, or remove and replace, defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
- 1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
  - 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
    - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
  - 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
  - 4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 017700

CLOSEOUT PROCEDURES

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## SECTION 017823 - OPERATION AND MAINTENANCE DATA

### 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 administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
  - 1. Operation and maintenance documentation directory manuals.
  - 2. Emergency manuals.
  - 3. Systems and equipment operation manuals.
  - 4. Systems and equipment maintenance manuals.
  - 5. Product maintenance manuals.
- B. Related Requirements:
  - 1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
  - 2. Section 019113 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

#### 1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
  - 1. Architect and Commissioning Authority and Beaverton School District will comment on whether content of operation and maintenance submittals is acceptable.

2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
  1. Submit by uploading to web-based project software site. Enable reviewer comments on draft submittals.
- C. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect and Commissioning Authority will return copy with comments.
  1. Correct or revise each manual to comply with Architect's and Commissioning Authority's and Beaverton School District's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's and Commissioning Authority's comments and prior to commencing demonstration and training.
- D. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

#### 1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic keyword searchable PDF file for each manual type required.
  1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
  2. For each product, provide 1 pdf containing all Product Data and 1 pdf containing the Warranty. Place pdfs into files named according to CSI format
  3. Provide all documents on USB Drive.

#### 1.6 REQUIREMENTS FOR OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manual: Unless otherwise indicated, organize single manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. The manual shall contain the following materials, in the order listed:
  1. Title page.
  2. Table of contents.
  3. Manual contents to be uploaded to web-based project software site
    - a. Contact list
    - b. Certificate of Substantial Completion (AIA G704-2000)
    - c. Contractor's Statement of Warranty
    - d. Lead Free Certification Letter

- e. Asbestos Free Certification Letter
- f. Certificate of Occupancy
- g. Final Permit Inspection Approvals
- h. Product Data (including shop drawings, where applicable) and Warranties organized by CSI Format.

## 1.7 OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
  - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
  - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
  - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
  - 2. Performance and design criteria if Contractor has delegated design responsibility.
  - 3. Operating standards.
  - 4. Operating procedures.
  - 5. Operating logs.
  - 6. Wiring diagrams.
  - 7. Control diagrams.
  - 8. Piped system diagrams.
  - 9. Precautions against improper use.
  - 10. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
  - 1. Product name and model number. Use designations for products indicated on Contract Documents.
  - 2. Manufacturer's name.
  - 3. Equipment identification with serial number of each component.
  - 4. Equipment function.
  - 5. Operating characteristics.
  - 6. Limiting conditions.
  - 7. Performance curves.
  - 8. Engineering data and tests.
  - 9. Complete nomenclature and number of replacement parts.
- D. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
  2. Equipment or system break-in procedures.
  3. Routine and normal operating instructions.
  4. Regulation and control procedures.
  5. Instructions on stopping.
  6. Normal shutdown instructions.
  7. Seasonal and weekend operating instructions.
  8. Required sequences for electric or electronic systems.
  9. Special operating instructions and procedures.
- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

#### 1.8 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
  2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: For each system, sub-system, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.
- C. Source Information: List each system, sub-system, and piece of equipment included in the manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

- a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.
- E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
  1. Test and inspection instructions.
  2. Troubleshooting guide.
  3. Precautions against improper maintenance.
  4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  5. Aligning, adjusting, and checking instructions.
  6. Demonstration and training video recording, if available.
- F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
  1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
  2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
  1. Include procedures to follow and required notifications for warranty claims.
- I. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
  1. Do not use original project record documents as part of maintenance manuals.

1.9 PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Product Information: Include the following, as applicable:
  - 1. Product name and model number.
  - 2. Manufacturer's name.
  - 3. Color, pattern, and texture.
  - 4. Material and chemical composition.
  - 5. Reordering information for specially manufactured products.
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
  - 1. Inspection procedures.
  - 2. Types of cleaning agents to be used and methods of cleaning.
  - 3. List of cleaning agents and methods of cleaning detrimental to product.
  - 4. Schedule for routine cleaning and maintenance.
  - 5. Repair instructions.
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
  - 1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 017823

OPERATION AND MAINTENANCE DATA

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## SECTION 017839 - PROJECT RECORD DOCUMENTS

### 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 administrative and procedural requirements for project record documents, including the following:
  - 1. Record Drawings.
  - 2. Record Specifications.
  - 3. Record Product Data.
  - 4. Miscellaneous record submittals.
- B. Related Requirements:
  - 1. Section 017700 "Closeout Procedures" for general closeout procedures.
  - 2. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

#### 1.3 PRELIMINARY CLOSEOUT SUBMITTALS

- A. Submit to the owner the following for review:
  - 1. Revit model detailed to LOD 300.
  - 2. CAD files & X-refs (ie Landscape dwgs).
  - 3. Draft Operations and Maintenance Manual.

#### 1.4 CLOSEOUT SUBMITTALS

- A. One (1) USB containing O&M Manual; Specs; Revit model; DWG files; pdfs of Record Drawings, Redline Drawings (scanned if necessary) and Permit Drawings (scanned)
- B. One (1) hard copy of Permit Drawing Set (original stamp, signature, & date)
- C. One (1) hard copy of Record Drawings + As – Built deferred submittals such as FA and FS
- D. One (1) hard copy Specifications book.

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- E. One (1) hard copy of the Irrigation Plan Color Coded
- F. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.

## 1.5 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
  - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Accurately record information in an acceptable drawing technique.
    - c. Record data as soon as possible after obtaining it.
    - d. Record and check the markup before enclosing concealed installations.
    - e. Cross-reference record prints to corresponding photographic documentation.
  - 2. Content: Types of items requiring marking include, but are not limited to, the following:
    - a. Dimensional changes to Drawings.
    - b. Revisions to details shown on Drawings.
    - c. Depths of foundations.
    - d. Locations and depths of underground utilities.
    - e. Revisions to routing of piping and conduits.
    - f. Revisions to electrical circuitry.
    - g. Actual equipment locations.
    - h. Duct size and routing.
    - i. Locations of concealed internal utilities.
    - j. Changes made by Change Order or Construction Change Directive.
    - k. Changes made following Architect's written orders.
    - l. Details not on the original Contract Drawings.
    - m. Field records for variable and concealed conditions.
    - n. Record information on the Work that is shown only schematically.
  - 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
  - 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
  - 5. Mark important additional information that was either shown schematically or omitted from original Drawings.

6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
  1. Format: Annotated PDF electronic file with comment function enabled Via USB Drive.
  2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
  3. Refer instances of uncertainty to Architect for resolution.
  4. Architect will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.
    - a. See Section 013100 "Project Management and Coordination" for requirements related to use of Architect's digital data files.
    - b. Architect will provide data file layer information. Record markups in separate layers.
- C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
  1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
  2. Format: Annotated PDF electronic file with comment function enabled via USB Drive.
  3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
  4. Identification: As follows:
    - a. Project name.
    - b. Date.
    - c. Designation "PROJECT RECORD DRAWINGS."
    - d. Name of Architect.
    - e. Name of Contractor.

## 1.6 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
  1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  2. Note related Change Orders and record Drawings where applicable.
- B. Format: Submit record Specifications as annotated PDF electronic file via USB drive.

## 1.7 RECORD PRODUCT DATA

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
  - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
  - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
  - 3. Note related Change Orders, record Specifications, and record Drawings where applicable.
- C. Format: Submit record Product Data as annotated PDF electronic file via USB Drive.
  - 1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

## 1.8 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. Format: Submit miscellaneous record submittals as PDF electronic file via USB Drive.
  - 1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

## 1.9 MAINTENANCE OF RECORD DOCUMENTS

- A. Maintenance of Record Documents: Store record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

## PART 2 - PRODUCTS (NOT USED)

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PART 3 - EXECUTION (NOT USED)

END OF SECTION 017839

PROJECT RECORD DOCUMENTS

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## SECTION 017900 - DEMONSTRATION AND TRAINING

### 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 administrative and procedural requirements for instructing Owner's personnel, including the following:
  - 1. Instruction in operation and maintenance of systems, subsystems, and equipment.
  - 2. Demonstration and training video recordings.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
  - 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
- B. Qualification Data: For facilitator.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module. Include Closed Captioning in video recordings.
  - 1. Identification: On each copy, provide an applied label with the following information:

- a. Name of Project.
  - b. Name and address of videographer.
  - c. Name of Architect.
  - d. Name of Construction Manager.
  - e. Name of Contractor.
  - f. Date of video recording.
2. At completion of training, submit complete training manual(s) for Owner's use prepared in same PDF file format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data."

## 1.5 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.
- D. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
  1. Inspect and discuss locations and other facilities required for instruction.
  2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
  3. Review required content of instruction.
  4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

## 1.6 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Architect.
- D. In addition to general building training the subcontractors to provide trade specific training for Mechanical and Electrical systems. This training shall be conducted during commissioning of the building, 3 months after building competition and prior to 1 year warranty expiration.
  - 1. Each training sessions to last a maximum of 8 hours.

## 1.7 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
  - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
    - a. System, subsystem, and equipment descriptions.
    - b. Performance and design criteria if Contractor is delegated design responsibility.
    - c. Operating standards.
    - d. Regulatory requirements.
    - e. Equipment function.
    - f. Operating characteristics.
    - g. Limiting conditions.
    - h. Performance curves.
  - 2. Documentation: Review the following items in detail:
    - a. Emergency manuals.
    - b. Systems and equipment operation manuals.
    - c. Systems and equipment maintenance manuals.
    - d. Product maintenance manuals.
    - e. Project Record Documents.
    - f. Identification systems.
    - g. Warranties and bonds.
    - h. Maintenance service agreements and similar continuing commitments.
  - 3. Emergencies: Include the following, as applicable:
    - a. Instructions on meaning of warnings, trouble indications, and error messages.
    - b. Instructions on stopping.

- c. Shutdown instructions for each type of emergency.
  - d. Operating instructions for conditions outside of normal operating limits.
  - e. Sequences for electric or electronic systems.
  - f. Special operating instructions and procedures.
- 4. Operations: Include the following, as applicable:
  - a. Startup procedures.
  - b. Equipment or system break-in procedures.
  - c. Routine and normal operating instructions.
  - d. Regulation and control procedures.
  - e. Control sequences.
  - f. Safety procedures.
  - g. Instructions on stopping.
  - h. Normal shutdown instructions.
  - i. Operating procedures for emergencies.
  - j. Operating procedures for system, subsystem, or equipment failure.
  - k. Seasonal and weekend operating instructions.
  - l. Required sequences for electric or electronic systems.
  - m. Special operating instructions and procedures.
- 5. Adjustments: Include the following:
  - a. Alignments.
  - b. Checking adjustments.
  - c. Noise and vibration adjustments.
  - d. Economy and efficiency adjustments.
- 6. Troubleshooting: Include the following:
  - a. Diagnostic instructions.
  - b. Test and inspection procedures.
- 7. Maintenance: Include the following:
  - a. Inspection procedures.
  - b. Types of cleaning agents to be used and methods of cleaning.
  - c. List of cleaning agents and methods of cleaning detrimental to product.
  - d. Procedures for routine cleaning.
  - e. Procedures for preventive maintenance.
  - f. Procedures for routine maintenance.
  - g. Instruction on use of special tools.
- 8. Repairs: Include the following:
  - a. Diagnosis instructions.
  - b. Repair instructions.

- c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
- d. Instructions for identifying parts and components.
- e. Review of spare parts needed for operation and maintenance.

## 1.8 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

## 1.9 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
  - 1. Owner will furnish an instructor to describe Owner's operational philosophy.
  - 2. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
  - 1. Schedule training with Owner with at least seven days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.
- F. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

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PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 017900

DEMONSTRATION AND TRAINING

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## SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. Commissioning: Commissioning is a systematic process of ensuring and documenting that all building systems perform interactively according to the design intent and the owner's operational needs. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training.
- B. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:
  - 1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
  - 2. Verify and document proper performance of equipment and systems.
  - 3. Verify that O&M documentation left on site is complete.
  - 4. Verify that the Owner's operating personnel are adequately trained.
- C. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

#### 1.2 COORDINATION

- A. Commissioning Team: The members of the commissioning team consist of the Commissioning Authority (CxA), the owner's designated Project Manager (PM), the General Contractor (GC or Contractor), the architect and design engineers, the Plumbing Contractor (PC), the Mechanical Contractor (MC), the Electrical Contractor (EC), the TAB representative, the Controls Contractor (CC), any other installing subcontractors or suppliers of equipment. If known, the Owner's building or plant operator/engineer is also a member of the commissioning team.
- B. Management: The CxA is hired by the Owner directly. The CxA directs and coordinates the commissioning activities. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents. The CxA's responsibilities are the same regardless of who hired the CxA.
- C. Scheduling: The CxA will work with the GC according to established protocols to schedule the commissioning activities. The CxA will provide sufficient notice to the PM and GC for scheduling commissioning activities. The GC will integrate all commissioning activities into the master schedule. All parties will address scheduling on an ongoing basis and make necessary notifications in a timely manner in order to expedite the commissioning process.

### 1.3 COMMISSIONING PROCESS

- A. Commissioning Process: The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
1. Commissioning during construction begins with a scoping meeting conducted by the CxA where the commissioning process is reviewed with the commissioning team members.
  2. Additional meetings will be required throughout construction, scheduled by the CxA with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.
  3. Equipment documentation is submitted to the CxA during normal submittals, including detailed start-up procedures.
  4. The CxA works with the Subs to develop startup plans and startup documentation formats, which may include providing the Subs with prefunctional checklists to be completed during the startup process.
  5. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with prefunctional checklists being completed before functional testing.
  6. The Subs, under their own direction, execute and document the prefunctional checklists and perform startup and initial checkout. The CxA documents that the checklists and startup were completed according to approved plans, and may witness startup of selected systems and equipment.
  7. The CxA develops specific equipment and system functional testing procedures. The Subs review the procedures.
  8. The procedures are executed/witnessed and documented by the CxA, with the assistance of the Subs as necessary.
  9. Items of non-compliance in material, installation, programming, calibration, start-up or setup are corrected at the Sub's expense and the system retested.
  10. The CxA reviews O&M's for all commissioned systems for completeness.
  11. The CxA reviews and approves training plans/agenda for training provided by the Subs (for commissioned equipment), and verifies that training was completed as per the contract documents.
  12. The CxA issues a report of the commissioning process and results.
  13. The CxA performs a Near-Warranty End or Post Occupancy Review approximately 10 months into the 12 month warranty period.

### 1.4 RELATED WORK

- A. Specific commissioning requirements are given in the following sections of these specifications. All of the following sections apply to the Work of this section.
1. Section 011000 "Summary" for Commissioning Authority responsibilities.
  2. Section 013300 "Submittal Procedures" for submittal procedure requirements for commissioning process.
  3. Section 017700 "Closeout Procedures" for Certificate of Construction-Phase Commissioning Process Completion submittal requirements.

## GENERAL COMMISSIONING REQUIREMENTS

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4. Section 017823 "Operation and Maintenance Data" for preliminary operation and maintenance data submittal requirements.
5. Section 019119.43 "Exterior Enclosure Commissioning" for technical commissioning requirements for exterior closure.
6. Section 210800 "Commissioning of Fire Suppression" for technical commissioning requirements for fire suppression.
7. Section 220800 "Commissioning of Plumbing" for technical commissioning requirements for plumbing.
8. Section 230800 "Commissioning of HVAC" for technical commissioning requirements for HVAC.
9. Section 260800 "Commissioning of Electrical Systems" for technical commissioning requirements for electrical systems.
10. Section 270800 "Commissioning of Communications" for technical commissioning requirements for communications systems.

## 1.5 RESPONSIBILITIES

- A. The responsibilities of various parties in the commissioning process are provided in this section. It is noted that the services for the Commissioning Authority, Project Manager, Construction Manager, Architect, and HVAC mechanical and electrical designers/engineers are not provided for in this contract. That is, the Contractor is not responsible for providing their services. Their responsibilities are listed here to clarify the commissioning process.
- B. All Parties
  1. Follow the Commissioning Plan and Cx Specification requirements.
  2. Attend commissioning scoping meeting and additional meetings, as necessary.
- C. Architect (of the A/E)
  1. Attend the commissioning scoping meeting and selected commissioning team meetings.
  2. Perform normal submittal review, construction observation, as-built drawing preparation, O&M manual preparation, etc., as contracted.
  3. Provide any design narrative documentation requested by the CxA.
  4. Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.
  5. Prepare and submit final as-built design intent documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.
- D. Mechanical and Electrical Designers/Engineers (of the A/E)
  1. Perform normal submittal review, construction observation, O&M review, etc., as contracted.
  2. Review and respond to CxA review comments of construction documents and O&M manuals.

3. Coordinate with CxA for review of contractor submittals. Review and respond to CxA review comments. Incorporate CxA comments into response to contractors as appropriate.
4. The designers shall assist (along with the contractors) 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.
5. Review draft functional/performance test procedures: respond with any comments.
6. Respond to issues in the Cx Log identified as awaiting action by Engineer.
7. Attend commissioning scoping meetings and other selected commissioning team meetings.
8. Participate in the resolution of system deficiencies identified during commissioning, according to the contract documents.

E. Commissioning Authority (CxA)

1. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CxA may assist with problem-solving, non-conformance or deficiencies, but ultimately that responsibility resides with the general contractor and the A/E. The primary role of the CxA is to develop and coordinate the execution of a testing plan, observe and document performance—that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents. The Contractors will provide all tools or the use of tools to start, check-out and functionally test equipment and systems, except for specified testing with portable data-loggers, which shall be supplied and installed by the CxA.
2. Coordinate the commissioning work and, with the GC and PM, ensure that commissioning activities are being scheduled into the master schedule.
3. Plan and conduct a commissioning scoping meeting and other commissioning meetings.
4. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures.
5. Before startup, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
6. Review and comment on Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the A/E reviews.
7. Prepare and distribute pre-functional checklists and startup forms.
8. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
9. Approve systems startup by reviewing start-up reports and by selected site observation.
10. Oversee sufficient functional testing of the control system and approve it to be used for TAB, before TAB is executed.
11. Review and comment on TAB report for commissioning related issues.
12. With necessary assistance and review from installing contractors, write the functional testing procedures for equipment and systems. This may include energy management

- control system trending, stand-alone data logger monitoring or manual functional testing. Submit to PM for review, and for approval if required.
13. Analyze any functional performance trend logs and monitoring data to verify performance.
  14. Witness selected startup/performance tests performed by installing contractors. Review and comment on test reports.
  15. Perform or witness functional test procedures on the commissioned equipment.
  16. Maintain a master deficiency and resolution log and a separate testing record. Provide the PM with written progress reports and test results with recommended actions.
  17. Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.
  18. Review Contractor's training plan for facility operating staff and building occupants. Verify Contractor's execution of plan.
  19. Review and comment on preliminary O&M manuals for commissioned systems.
  20. Provide a final commissioning report (as described in this section).
  21. Coordinate and supervise required seasonal or deferred testing and deficiency corrections.
  22. Return to the site at 10 months into the 12 month warranty period and do a brief review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning. Identify problems or concerns staff have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract.

F. Owner's Project Manager (PM)

1. Manage the contract of the A/E and of the GC.
2. Provide final approval for the completion of the commissioning work.
3. Provide construction documents for CxA review.
4. Review draft functional/performance test procedures; respond with any comments.
5. Respond to issues in the Cx Log identified as awaiting action by Owner.
6. Attend commissioning meetings.
7. Forward to CxA any start-up forms produced by vendors hired by owner.
8. Arrange for O&M staff to attend contractor training sessions; coordinate with GC and/or Subs to schedule.
9. Forward O&M manuals for any commissioned equipment provided by owner to CxA for review.
10. Ensure that any seasonal or deferred testing and any deficiency issues are addressed.

G. General Contractor (GC)

1. Designate one of their staff to be the General Contractor's Cx Coordinator, with whom the CxA coordinates all contractor Cx responsibilities.
2. Facilitate the coordination of the commissioning work by the CxA, and with the CxA ensure that commissioning activities are being scheduled into the master schedule.
3. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.

4. In each purchase order or subcontract written, include requirements for submittal data, O&M data, commissioning tasks and training.
5. Ensure that all Subs execute their commissioning responsibilities according to the Contract Documents and schedule.
6. A representative shall attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.
7. Schedule subcontractors to attend commissioning meetings when requested by CxA.
8. Deliver Pre-Functional checklists to subcontractors, collect completed forms and forward to CxA.
9. Forward completed contractor and vendor Start-up Forms for commissioned equipment to the CxA.
10. Submit RFI's generated by the CxA to the A/E.
11. Notify CxA when all Pre-Functional Checklists and Start-up Forms have been completed and systems are ready for Functional/performance testing.
12. Respond to all issues in the Cx Log identified as awaiting action by the GC.
13. Coordinate the training of owner personnel. Forward training plans and records to CxA for review.
14. Prepare O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions and make available to the CxA, concurrent with the A/E review.
15. Ensure that Subs correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

#### H. Equipment Suppliers

1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
2. Assist in equipment testing per agreements with Subs.
3. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor, except for stand-alone data logging equipment that may be used by the CxA.
4. Through the contractors they supply products to, analyze specified products and verify that the designer has specified the newest most updated equipment reasonable for this project's scope and budget.
5. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
6. Review test procedures for equipment installed by factory representatives.

#### I. Subcontractors

1. Refer to division specific commissioning specification sections listed under 019113 part 1.4, "Related Work" for responsibilities specific to each subcontractor.

### 1.6 SYSTEMS TO BE COMMISSIONED

- A. The following equipment and associated systems will be commissioned in this project:

### GENERAL COMMISSIONING REQUIREMENTS

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1. Division 22: Plumbing Systems
    - a. Domestic Hot and Cold water systems
    - b. Hot water recirculation system
  2. Division 23: HVAC Systems
    - a. Air handling units
    - b. Exhaust fans
    - c. Terminal units
    - d. Heating water system
    - e. Airflow measuring stations
    - f. Control system for commissioned equipment
  3. Division 26: Electrical Systems
    - a. Lighting controls
  4. Division 28: Fire Detection and Alarm
    - a. Interface with life safety systems, fire protection systems, HVAC systems and elevators
- B. General references to equipment will refer to the above systems and their components.

## PART 2 - PRODUCTS

### 2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup and initial checkout and required functional testing shall be provided by the Division contractor for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all standard testing equipment for the HVAC system and controls system in Division 23, except for equipment specific to and used by the TAB contractor in their commissioning responsibilities.
- B. Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and left on site, except for stand-alone data-logging equipment that may be used by the CxA.
- C. Data-logging equipment and software required to test equipment will be provided by the CxA for use by the CxA only, and shall not become the property of the Owner.
- D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the *Specifications*. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of  $\pm 0.5^{\circ}\text{F}$  and a resolution of  $\pm$

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0.2°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

## PART 3 - EXECUTION

### 3.1 MEETINGS

- A. Scoping Meeting: Within 60 days of commencement of construction, the CxA will schedule, plan and conduct a commissioning kickoff meeting with the entire commissioning team in attendance. Information gathered from this meeting will be used by the CxA to revise the Draft Commissioning Plan to its "final" version.
- B. Miscellaneous Meetings: CxA may attend regular construction meetings to keep informed of project progress & coordinate the commissioning activities. Other meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular Subs. The CxA will plan these meetings and will minimize unnecessary time being spent by Subs.

### 3.2 REPORTING

- A. The CxA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos, progress reports, etc.
- B. A final summary report (about four to six pages, not including backup documentation) by the CxA will be provided to the PM, focusing on evaluating commissioning process issues and identifying areas where the process could be improved. All acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., will be compiled in appendices and provided with the summary report.

### 3.3 SUBMITTALS

- A. The CxA will provide appropriate contractors with a specific request for the type of submittal documentation the CxA requires to facilitate the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum, the request will include the manufacturer and model number, the manufacturer's printed installation and detailed start-up procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details of owner contracted tests. In addition, the installation 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 Authority. All documentation requested by the CxA will be included by the Subs in their O&M manual contributions.

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- B. The CxA may request additional design narrative from the A/E and Controls Contractor, depending on the completeness of the design intent documentation and sequences provided with the Specifications.
- C. The Commissioning authority will review and approve submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the functional performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of functional testing procedures and only secondarily to verify compliance with equipment specifications, which is the A/E's responsibility. The Commissioning authority will notify the GC, PM or A/E as requested, of items missing or areas that are not in conformance with Contract Documents and which requires resubmission.
- D. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the CxA will review and approve them.

#### 3.4 START-UP, PREFUNCTIONAL CHECKLISTS AND INITIAL CHECKOUT

- A. The following procedures apply to all equipment to be commissioned, according to Section 1.06, Systems to be Commissioned.
- B. General: Prefunctional checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout. No sampling strategies are used. The prefunctional testing for a given system must be successfully completed prior to formal functional testing of equipment or subsystems of the given system.
- C. Start-up and Initial Checkout Plan: The CxA shall assist the contractor in developing pre-functional checklists and a detailed start-up plan for all commissioned equipment. The primary role of the CxA in this process is ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.
  - 1. The subcontractor responsible for the purchase of the equipment develops the full start-up plan. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
  - 2. The full start-up plan could consist of something as simple as:
    - a. The CxA's, contractor's or manufacturer's prefunctional checklists.
    - b. The manufacturer's standard written start-up procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
    - c. The manufacturer's normally used field checkout sheets.

3. The subcontractor submits the full startup plan to the CxA for review and approval.
4. The CxA reviews and approves the procedures and the format for documenting them, noting any procedures that need to be added.
5. The full start-up procedures and the approval form may be provided to the PM for review and approval, depending on management protocol.

D. Execution of Prefunctional Checklists and Startup.

1. Four weeks prior to startup, the Subs and vendors schedule startup and checkout with the PM, GC and CxA. The performance of the prefunctional checklists, startup and checkout are directed and executed by the Sub or vendor. When checking off prefunctional checklists, signatures may be required of other Subs for verification of completion of their work.
2. The CxA shall verify compliance on at least 20% of equipment requiring formal start-up procedures.
3. The Subs and vendors shall execute startup and provide the CxA with a signed and dated copy of the completed start-up and prefunctional tests and checklists.

E. Only individuals that have direct knowledge and witnessed that a line item task on the prefunctional checklist was actually performed shall initial or check that item off. It is not acceptable for supervisors to fill out these forms unless they have personally witnessed or verified each item.

F. Deficiencies, Non-Conformance and Approval in Checklists and Startup.

1. The Subs shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the CxA within two days of test completion.
2. The CxA reviews the report and submits either a non-compliance report or an approval form to the Sub or PM. The CxA will work with the Subs and vendors to correct and retest deficiencies or uncompleted items. The CxA will involve the PM, GC and others as necessary. The installing Subs or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CxA as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report.
3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back-charges to the responsible party. Refer to Part 3.6 herein for details.

### 3.5 FUNCTIONAL TESTING

- A. This sub-section applies to all commissioning functional testing for all divisions.
- B. The general list of equipment to be commissioned is found in Section 01 91 00, Part 1.06.
- C. Objectives and Scope: The objective of functional testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional

testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required.

- D. Development of Test Procedures: Before test procedures are written, the CxA shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. The CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Sub or vendor shall provide limited assistance to the CxA in developing the procedures (answering questions about equipment, operation, sequences, etc.). Prior to execution, the CxA shall provide a copy of the test procedures to the Sub(s) who shall review the tests for feasibility, safety, equipment and warranty protection. The CxA may submit the tests to the A/E for review, if requested.

E. Test Methods

1. Functional testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data-loggers.
2. Simulated Conditions: Simulating conditions (not by an overwritten value) is allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
3. Overwritten Values: Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, is allowed, but will be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair dryer rather than overwriting the value or by altering the appropriate set point to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.
4. Altering Set Points: Rather than overwriting sensor values, and when simulating conditions is difficult, altering set points to test a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, temporarily change the lockout set point to be 2F above the current outside air temperature.
5. Indirect Indicators: Relying on indirect indicators for responses or performance is allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification is completed during prefunctional testing.
6. Setup: Each function and test will be performed under conditions that simulate actual conditions as close as is practically possible. At completion of the test, the CxA will

return all affected building equipment and systems, due to temporary modifications, to their pre-test condition.

7. Sampling

- a. Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy as approved by the owner representative. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference. It is noted that no sampling by Subs is allowed in prefunctional checklist execution.
- b. A common sampling strategy is the “xx% Sampling—yy% Failure Rule”, defined by the following example.
  - 1) xx = the percent of the group of identical equipment to be included in each sample.
  - 2) yy = the percent of the sample that if failing, will require another sample to be tested.
  - 3) The example below describes a 20% Sampling—10% Failure Rule.
    - a) Randomly test at least 20% (xx) of each group of identical equipment. In no case test less than three units in each group. This 20%, or three, constitute the “first sample.”
    - b) If 10% (yy) of the units in the first sample fail the functional testings, test another 20% of the group (the second sample).
    - c) If 10% of the units in the second sample fail, test all remaining units in the whole group.
    - d) If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the CxA may stop the testing and require the responsible Sub to perform and document a checkout of the remaining units, prior to continuing with functionally testing the remaining units.

F. Coordination and Scheduling.

1. The Subs shall provide sufficient notice to the CxA regarding their completion schedule for the prefunctional checklists and startup of all equipment and systems. The Controls Contractor will provide written notification that they have completed all required prefunctional checklists, point-to-point verification, sensor calibration verification, programming verification checks, and that their system(s) are complete and ready for functional testing before testing will proceed. The CxA will schedule functional tests through the PM, GC and affected Subs. The CxA will develop, execute and document the functional testing of all equipment and systems.
2. In general, functional testing is conducted after prefunctional testing and startup has been satisfactorily completed. The control system is complete and pre-functionally tested before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to

subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.

- G. Test Equipment: Refer to Section 01 91 00, Part 2 for test equipment requirements.
- H. Problem Solving: The CxA will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the GC, Subs and A/E.

### 3.6 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

- A. Documentation: The CxA will document the results of all functional tests using the specific procedural forms developed for that purpose. Prior to testing, these forms are provided to the PM for review and approval and to the Subs for review.
- B. Non-Conformance
  - 1. The CxA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the PM on the CxA's standard issues tracking form.
  - 2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
  - 3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work, loosening acceptance criteria, or combining CxA functional testing with the contractor QA checkout procedures to satisfy scheduling or cost.
  - 4. A complete round of tests will be performed, with results and deficiencies reported to the Subs and the PM. The responsible Subs will then have an opportunity to correct the deficiencies and schedule re-testing. Re-testing of up to 10% of the total number of executed tests will be provided by the CxA at no additional charge. Costs of additional re-testing will be as described in the next section.
    - a. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:
      - 1) The CxA documents the deficiency and the Sub's response with intentions and they go on to another test or sequence. The Sub corrects the deficiency and notifies the CxA that the system is ready to be retested.
      - 2) The CxA reschedules the test and the test is repeated.
    - b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:

- 1) The deficiency shall be documented on the non-compliance form with the Sub's response and a copy given to the PM and to the Sub representative assumed to be responsible.
    - 2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Project Manager.
    - 3) The CxA documents the resolution process.
    - 4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CxA. The CxA reschedules the test and the test is repeated until satisfactory performance is achieved.
  5. Cost of Retesting.
    - a. The time for the CxA to execute any re-testing required because a specific *prefunctional* checklist or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, may be back-charged to the GC, who may choose to recover costs from the party responsible for executing the faulty prefunctional check.
    - b. For a deficiency identified, not related to any prefunctional checklist or start-up fault, the following shall apply: The CxA and PM will direct the retesting of up to 10% of the total executed tests once at no "charge" to the GC for their time. However, the CxA's time for a second test will be charged to the GC, who may choose to recover costs from the responsible Sub.
    - c. Refer to the sampling section of Section 01 91 00, Part 3.05 for requirements for testing and retesting identical equipment.
  6. The Contractor shall respond in writing to the CxA and PM the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
  7. Any required re-testing shall not be considered a justified reason for a claim of delay or for a time extension by the prime contractor.
- C. Approval: The CxA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CxA and by the CM, if necessary. The CxA recommends acceptance of each test to the CM using a standard form.

### 3.7 OPERATION AND MAINTENANCE MANUALS AND FINAL REPORT

#### A. Standard O&M Manuals.

1. The specific content and format requirements for the standard O&M manuals are detailed in Division 01, with specific section requirements in Divisions 22, 23 & 26 for commissioned equipment.
2. CxA Review and Approval: Prior to substantial completion, the CxA will review the O&M manuals, documentation and redline as-builds *for systems that were commissioned*

to verify compliance with the *Specifications*. The CxA will communicate deficiencies in the manuals to the PM or A/E, as requested. The CxA also reviews each equipment warranty and verifies that all requirements to keep the warranty valid are clearly stated. This work does not supersede the A/E's review of the O&M manuals according to the A/E's contract.

B. Final Commissioning Report

1. The final commissioning report will include an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope and a general description of testing and verification methods. For each piece of commissioned equipment, the report should contain the disposition of the commissioning authority regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas: 1) Equipment meeting the equipment specifications, 2) Equipment installation, 3) Functional performance and efficiency, 4) Equipment documentation and design intent, and 5) Operator training. All outstanding non-compliance items will be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. will also be listed. Each non-compliance issue will be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented. The functional performance and efficiency section for each piece of equipment will include a brief description of the verification method used (manual testing, BAS trend logs, data loggers, etc.) and include observations and conclusions from the testing.
2. Other documentation will be retained by the CxA.

3.8 TRAINING OF OWNER PERSONNEL

- A. The GC shall be responsible for training coordination and scheduling and ultimately for ensuring that training is completed. NWEI's scope does not include any training review.

3.9 DEFERRED TESTING

- A. Unforeseen Deferred Tests: If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the PM. These tests will be conducted as soon as possible. Services of necessary parties will be negotiated.

3.10 WRITTEN WORK PRODUCTS

- A. The commissioning process generates a number of written work products described in various parts of the *Specifications*. The *Commissioning Plan* lists all the formal written work products, describes briefly their contents, who is responsible to create them, their due dates, who receives and approves them and the location of the specification to create them.

B. In summary, the written products are:

Item no.	Product	Developed by
01 9100-1	Equipment documentation submittals	Subs
01 9100-2	Sequence clarifications	Subs and A/E as needed
01 9100-3	Pre-functional checklists	CxA
01 9100-4	Start-up and initial checkout plan	Subs w/ assistance from CxA
01 9100-5	Pre-functional checklists filled out	Subs
01 9100-6	Start-up and initial checkout forms filled out	Subs
01 9100-7	Final TAB report	TAB
01 9100-8	Issues log (deficiencies)	CxA
01 9100-9	Functional test forms	CxA
01 9100-10	Filled out functional tests	CxA
01 9100-11	Training plans and records	Subs
01 9100-12	O&M manuals	Subs
01 9100-13	Final Commissioning Report	CxA

END OF SECTION 019113

# **The Commissioning Process**

Approved by the ASHRAE Standards Committee on February 9, 2005, and by the ASHRAE Board of Directors on March 11, 2005.

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**NOTE**

**When addenda, interpretations, or errata to this guideline have been approved, they can be downloaded free of charge from the ASHRAE Web site at <http://www.ashrae.org>.**

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1791 Tullie Circle NE  
Atlanta, GA 30329  
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## FOREWORD

*The Commissioning Process is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria.*

*The Commissioning Process assumes that owners, programmers, designers, contractors, and operations and maintenance entities are fully accountable for the quality of their work. The Commissioning Team uses methods and tools to verify that the project is achieving the Owner's Project Requirements throughout the delivery of the project. For example, the contractor is responsible for fully constructing, testing, and ensuring that its employees' work has provided the level of quality expected. The Commissioning Authority then randomly samples the contractor's work to verify that it is achieving the Owner's Project Requirements. If systemic issues are identified, then the contractor is expected to recheck all of his/her work and correct any deficiencies. This quality-oriented process is different than when the Commissioning Authority does 100% checking or non-quality-based sampling. Guideline 0 has been developed to present an approach based on these assumptions.*

*The Commissioning Process begins at project inception (during the Pre-Design Phase) and continues for the life of the facility (through the Occupancy and Operations Phase). Because this Guideline details a process, it can be applied to both new and renovation projects. The Commissioning Process includes specific tasks to be conducted during each phase in order to verify that design, construction, and training meet the Owner's Project Requirements. This Guideline describes the overall Commissioning Process in order to provide a uniform, integrated, and consistent approach for delivering and operating facilities that meet an owner's ongoing requirements.*

*The Commissioning Process is a quality-based method that is adopted by an Owner to achieve successful construction projects. It is not an additional layer of construction or project management. In fact, its purpose is to reduce the cost of delivering construction projects and increase value to owners, occupants, and users. This Guideline has been developed*

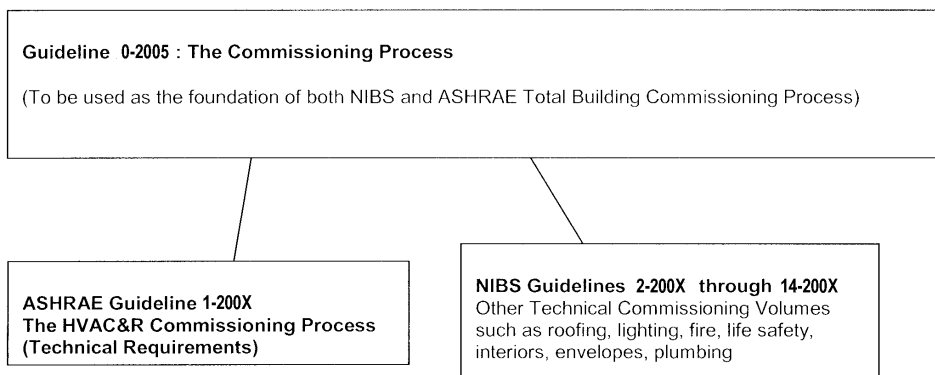
*to assist those who are adopting or plan to adopt a better quality-based and cost-effective process.*

*Development of guidelines for the Commissioning Process began formally in 1982 when the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) formed a committee to document best practices to achieve facilities that performed according to the owner's project requirements. ASHRAE published its original commissioning guideline in 1989 and an updated version in 1996. The Commissioning Process detailed in these guidelines is the result of experience on projects requiring that systems and assemblies worked from the first day the project was turned over to the owner. This Commissioning Process is further based upon experience with projects that met the requirements of owners, occupants, users of processes, and facility operating-maintenance-service organizations at a high level of satisfaction and that reduced the cost to deliver the project.*

*Guideline 0 is an integral part of the National Institute of Building Sciences (NIBS) total building commissioning guideline series. The relationship of this guideline to other technical commissioning guidelines is shown below.*

*Guideline 0 presents details on the Commissioning Process without focusing upon specific systems or assemblies. Supplementary technical guidelines are being developed to provide specific and detailed information on how to implement the Commissioning Process for each major building/facility system or assembly. For example, this Guideline details what is required for a high-quality and effective Systems Manual and how and when it is developed, whereas a technical guideline details what specific information for a given system or assembly must be included in the Systems Manual.*

*The use of a common content organization and the focus upon specific information achieve a closely coordinated set of documents that can be used together or in any combination to accommodate varying owner requirements. This Commissioning Process guideline allows the technical commissioning guidelines to avoid repeating information on the commissioning process, making them more concise and focused relative to their technical requirements.*



*The fundamental objectives of the Commissioning Process are to:*

- (a) *Clearly document Owner's Project Requirements;*
- (b) *Provide documentation and tools to improve the quality of deliverables;*
- (c) *Verify and document that systems and assemblies perform according to the Owner's Project Requirements;*
- (d) *Verify that adequate and accurate system and assembly documentation is provided to the owner;*
- (e) *Verify that operation and maintenance personnel and occupants are properly trained;*
- (f) *Provide a uniform and effective process for delivery of construction projects;*
- (g) *Deliver buildings and construction projects that meet the owner's needs, at the time of completion;*
- (h) *Utilize quality-based sampling techniques to detect systemic problems, as such sampling provides high value, efficient verification, accurate results, and reduced project costs; and*
- (i) *Verify proper coordination among systems and assemblies, and among all contractors, subcontractors, vendors, and manufacturers of furnished equipment and assemblies.*

*Due to the integration and interdependency of facility systems, a performance deficiency in one system can result in less than optimal performance by other systems. Implementing the Commissioning Process is intended to reduce the project capital cost through the first year of operation and also reduce the life-cycle cost of the facility. Using this integrated process results in a fully functional, fine-tuned facility, with complete documentation of its systems and assemblies and trained operating and maintenance personnel.*

*Emphasis is placed on documentation of the Owner's Project Requirements at the inception of the project and the proper transfer of this information from one party to the next. Owners adopt the Commissioning Process to achieve their stated objectives and criteria—starting with the inception of a project instead of after a facility is occupied.*

*While circumstances may require owners to adopt the Commissioning Process during the Design or Construction Phase of a project, such later implementation must capture the information that would have been developed had the Commissioning Process begun at project inception. Beginning the Commissioning Process at project inception will achieve the maximum benefits.*

*Annexes to this document have been included to assist in further understanding the Commissioning Process and to aid in the development of the technical guidelines. The Annexes are based on specific project experience, with details on what is current best practice. Annexes illustrate varying applications of the Commissioning Process for all projects. Therefore, Annexes should be viewed as examples of how to develop documents and to define Owner's Project Requirements, Basis of Design, Commissioning Plan, benefits and roles in the Commissioning Process, verification, testing requirements, documentation, and training.*

*The Commissioning Process has been structured to coincide with the phases of a generic project with Pre-Design, Design, Construction, and Occupancy and Operations phases.*

*This guideline describes the Commissioning Process; the responsibilities of Commissioning Team participants; the role of the Commissioning Authority; and a model framework for developing a Commissioning Plan, specifications, and reports. This guideline also describes the general requirements for a training program for continued successful system and assembly performance. Documentation necessary to meet the guideline requirements is also described.*

## **1. PURPOSE**

**1.1** The purpose of this guideline is to describe the Commissioning Process capable of verifying that a facility and its systems meet the Owner's Project Requirements.

## **2. SCOPE**

**2.1** The procedures, methods, and documentation requirements in this guideline describe each phase of the project delivery and the associated Commissioning Processes from pre-design through occupancy and operation, without regard to specific elements, assemblies, or systems, and provide the following:

- (a) overview of Commissioning Process activities,
- (b) description of each phase's processes,
- (c) requirements for acceptance of each phase,
- (d) requirements for documentation of each phase, and
- (e) requirements for training of operation and maintenance personnel.

**2.2** These Commissioning Process guideline procedures include the Total Building Commissioning Process (TBCxP) as defined by National Institute of Building Sciences (NIBS) in its *Commissioning Process Guideline 0*.

## **3. UTILIZATION**

**3.1** The application of this guideline will depend upon the Owner's Project Requirements and how the project will be designed, built, and operated. The process described in this guideline is written for a generic project and must be adapted to each project.

**3.2** This guideline describes the Commissioning Process, and is supplemented by companion technical guidelines. A technical guideline describes the specific details to properly implement the Commissioning Process relative to a specific facility system or assembly. Annex A in this guideline provides the required format for developing technical guidelines for the Commissioning Process.

## **4. DEFINITIONS**

**Acceptance:** A formal action, taken by a person with appropriate authority (which may or may not be contractually defined) to declare that some aspect of the project meets defined requirements, thus permitting subsequent activities to proceed.

**Basis of Design:** A document that records the concepts, calculations, decisions, and product selections used to meet the Owner's Project Requirements and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

**Checklists:** Verification checklists that are developed and used during all phases of the commissioning process to verify that the Owner's Project Requirements are being achieved. This includes checklists for general verification, plus testing, training, and other specific requirements.

**Commissioning:** See *Commissioning Process*.

**Commissioning Authority:** An entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the Commissioning Process.

**Commissioning Plan:** A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the Commissioning Process.

**Commissioning Process:** A quality-focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's Project Requirements.

**Commissioning Process Activities:** Components of the Commissioning Process.

**Commissioning Process Progress Report:** A written document that details activities completed as part of the Commissioning Process and significant findings from those activities, which is continuously updated during the course of a project. Usually incorporated into the Commissioning Plan as an ongoing appendix.

**Commissioning Process Report:** A document that records the activities and results of the Commissioning Process. Usually developed from the final Commissioning Plan with all of its attached appendices.

**Commissioning Team:** The individuals who through coordinated actions are responsible for implementing the Commissioning Process.

**Construction Checklist:** A form used by the contractor to verify that appropriate components are onsite, ready for installation, correctly installed, and functional. Also see *Checklists*.

**Construction Documents:** These include a wide range of documents that will vary from project to project and with the Owner's needs and with regulations, laws, and countries. Construction documents usually include the project manual (specifications), plans (drawings), and general terms and conditions of the contract.

**Continuous Commissioning Process:** A continuation of the Commissioning Process well into the Occupancy and Operations Phase to verify that a project continues to meet current and evolving Owner's Project Requirements. Continuous Commissioning Process activities are ongoing for the life of the facility. Also see *Ongoing Commissioning Process*.

**Contract Documents:** These include a wide range of documents that will vary from project to project and with the Owner's needs and with regulations, laws, and countries. Contract Documents frequently include price agreements, construction management process, subcontractor agreements or requirements, requirements and procedures for submittals, changes, and other construction requirements, timeline for completion, and the Construction Documents.

**Coordination Drawings:** Drawings showing the work of all trades to illustrate that equipment can be installed in the space allocated without compromising equipment function or access for maintenance and replacement. These drawings graphically illustrate and dimension manufacturers' recommended maintenance clearances.

**Issues Log:** A formal and ongoing record of problems or concerns – and their resolution – that have been raised by members of the Commissioning Team during the course of the Commissioning Process.

**Nominal Group Technique:** A formal, structured brainstorming process used to obtain the maximum possible ranked input from a variety of viewpoints in a short period of time. The typical approach is a workshop session where a question is presented, the attendees record their responses individually on a piece of paper, the individual responses are recorded on a flip chart without discussion in a round robin fashion, all of the responses are discussed, and then the participants rank their top five responses.

**Ongoing Commissioning Process:** A continuation of the Commissioning Process well into the Occupancy and Operations Phase to verify that a project continues to meet current and evolving Owner's Project Requirements. Ongoing Commissioning Process activities occur throughout the life of the facility; some of these will be close to continuous in implementation, and others will be either scheduled or unscheduled (as needed). Also see *Continuous Commissioning Process*.

**Owner's Project Requirements:** A written document that details the functional requirements of a project and the expectations of how it will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. (The term *Project Intent* is used by some owners for their Commissioning Process Owner's Project Requirements.)

**Quality Based Sampling:** A process for evaluating a subset (sample) of the total population. The sample is based upon a known or estimated probability distribution of expected values; an assumed statistical distribution based upon data from a similar product, assembly, or system; or a random sampling that has scientific statistical basis.<sup>1, 2, 3</sup>

**Re-Commissioning:** An application of the Commissioning Process requirements to a project that has been delivered using the Commissioning Process. This may be a scheduled re-commissioning developed as part of an *Ongoing Commissioning Process*, or it may be triggered by use change, operations problems, or other needs.

**Retro-Commissioning:** The Commissioning Process applied to an existing facility that was not previously commissioned. This guideline does not specifically address retro-commissioning. However, the same basic process needs to be followed from Pre-Design through Occupancy and Operations to optimize the benefits of implementing the Commissioning Process philosophy and practice.

**Systems Manual:** A system-focused composite document that includes the operation manual, maintenance manual, and additional information of use to the Owner during the Occupancy and Operations Phase.

**Test Procedure:** A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.

**Training Plan:** A written document that details the expectations, schedule, budget, and deliverables of Commissioning Process activities related to training of project operating and maintenance personnel, users, and occupants.

**Verification:** The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the Owner's Project Requirements.

## 5. PRE-DESIGN PHASE

### 5.1 Introduction

**5.1.1** Pre-Design is a preparatory phase of the project delivery process in which the Owner's Project Requirements are developed and defined. Information about the project is gathered, including program requirements, community context, codes and regulations, site and climate, facility context and function, facility technology, sustainability, cost, schedule, and the client's (including owner, occupants, operators, and maintenance personnel) needs and capabilities.

**5.1.2** This phase is critical to the Commissioning Process because the documented Owner's Project Requirements form the foundation for the design, construction, and occupancy and operation of the facility and are the basis for the Commissioning Plan and schedule. Starting the Commissioning Process during the Pre-Design Phase facilitates project communication by monitoring the Owner's Project Requirements from Pre-Design through Design, Construction, and Occupancy and Operations and by verifying decisions in these phases with the written documents called the Owner's Project Requirements and the Basis of Design.

**5.1.3** Pre-Design Phase Commissioning Process objectives include the following:

- (a) Developing the Owner's Project Requirements.
- (b) Identifying a scope and budget for the Commissioning Process.
- (c) Developing the initial Commissioning Plan.
- (d) Acceptance of Pre-Design Phase Commissioning Process activities.
- (e) Review and use of lessons-learned information from previous projects.

## 5.2 Pre-Design Phase Commissioning Process Activities

### 5.2.1 Pre-Design Phase Commissioning Process Responsibilities

**5.2.1.1** During the Pre-Design Phase, a Commissioning Team is formed to oversee, implement, and accomplish the Commissioning Process activities detailed in this guideline. Responsibility for leadership of the Commissioning Team should be defined and assigned at the beginning of the Pre-Design Phase. The term used for the person with overall responsibility for the Commissioning Process is "Commissioning Authority." The Commissioning Team members must be available for meetings, have the qualifications to contribute to the development of the Owner's Project Requirements, and have the authority to make decisions binding on the firms/constituencies they represent. Lines of authority and lines of communication in determining Commissioning Team members' responsibilities shall be documented. The Commissioning Team composition must be based upon the scope of the Commissioning Process services established for the project.

**5.2.1.2** The Owner must assign (or contract for) appropriate representatives to participate on the Commissioning Team – both from within and external to their organization. Commissioning Team responsibilities should be consistent with the agreements between parties involved in the project – and such agreements must clearly address Commissioning Process responsibilities.

**5.2.1.3** Essential team members during the Pre-Design Phase include Owner's representatives, the Commissioning Authority, pre-design and programming professionals, design professionals, and (if known) the construction/program/project managers. The Commissioning Authority can assist the Owner in identifying and selecting these initial Commissioning Team members. Owner's representatives will include the project manager, occupants or users, facility manager, and operation and maintenance personnel. Including operation and maintenance personnel on the Commissioning Team will help ensure that important operation and maintenance issues are included in the Owner's Project Requirements. The Owner will generally need to reconcile conflicting project requirements and provide feedback on decisions to the Commissioning Team. The design team members and Commissioning Authority can assist the Owner in reconciling conflicting technical requirements.

**5.2.1.4** The Commissioning Team will evolve as a project progresses. During successive phases, the active membership of the Commissioning Team may shift to meet the unique requirements of each phase. Contractors and vendors, for example, may join the Commissioning Team after they are under contract or after the start of construction.

**5.2.1.5** Pre-Design Phase Commissioning Process activities described in this section to be performed by the design team must be included in the scope of services described in the "Owner - Design Professional Service Agreement." These Commissioning Process activities may be more than are normally required in their scope of services. The scope of services in the "Owner - Design Professional Service Agreement" should also include the requirement to cooperate with the

Commissioning Authority during Pre-Design, Design, and Construction phases of the project. This may include testing soils, surveying, or other requirements during Pre-Design.

**5.2.1.6** Responsibilities of the Commissioning Team during the Pre-Design Phase include the following:

- (a) Assist Owner in preparing requests for project services that outline the roles and responsibilities developed in the Commissioning Plan.
- (b) Facilitate development and documentation of the Owner's Project Requirements.
- (c) Develop scope and format for project Systems Manual and select/designate entity responsible for developing this manual. Add this entity to the Commissioning Team where appropriate.
- (d) Develop scope and budget for project-specific Commissioning Process activities.
- (e) Verify that Commissioning Process activities are clearly stated in all project scopes of work.
- (f) Integrate the Commissioning Process activities into the project schedule.
- (g) Build and maintain cohesiveness and cooperation among the project team.
- (h) Coordinate Owner's representative's participation as defined in Section 5.2.1.2.
- (i) Conduct and document Commissioning Team meetings.
- (j) Identify who will accomplish the Commissioning Process activities.
- (k) Review Pre-Design Phase documents for compliance with the Owner's Project Requirements.
- (l) Write the initial Commissioning Plan.
- (m) Develop the initial format to be used for Issues Logs throughout, and for each phase of, the Commissioning Process.
- (n) Track and document issues and deviations relating to the Owner's Project Requirements and document resolutions in the Issues Log.
- (o) Write and review Commissioning Process Progress Reports.

## **5.2.2 Develop Owner's Project Requirements**

**5.2.2.1** The Owner's Project Requirements form the basis from which all design, construction, acceptance, and operational decisions are made. An effective Commissioning Process depends upon a clear, concise, and comprehensive Owner's Project Requirements document. It includes information to help the project team to properly plan, design, construct, operate, and maintain systems and assemblies.

**5.2.2.2** The Commissioning Authority facilitates the development of the Owner's Project Requirements. Input will be gathered from all team members.

**5.2.2.3** Each item of the Owner's Project Requirements shall have defined performance and acceptance criteria. Those that can be benchmarked should have the benchmark

defined in specific terms and the means of measurement defined.

**5.2.2.4** The Owner's Project Requirements should include the following:

- (a) Project schedule and budget.
- (b) Commissioning Process scope and budget.
- (c) Project documentation requirements, including format for submittals, training materials, reports, and the Systems Manual. Consideration should be given to use of electronic format documents and records where appropriate.
- (d) Owner directives.
- (e) Restrictions and limitations.
- (f) User requirements.
- (g) Occupancy requirements and schedules.
- (h) Training requirements for Owner's personnel.
- (i) Warranty requirements.
- (j) Benchmarking requirements.
- (k) Operation and maintenance criteria for the facility that reflect the Owner's expectations and capabilities and the realities of the facility type.
- (l) Equipment and system maintainability expectations, including limitations of operating and maintenance personnel.
- (m) Quality requirements for materials and construction.
- (n) Allowable tolerance in facility system operations.
- (o) Energy efficiency goals.
- (p) Environmental and sustainability goals.
- (q) Community requirements.
- (r) Adaptability for future facility changes and expansion.
- (s) Systems integration requirements, especially across disciplines.
- (t) Health, hygiene, and indoor environment requirements.
- (u) Acoustical requirements.
- (v) Vibration requirements.
- (w) Seismic requirements.
- (x) Accessibility requirements.
- (y) Security requirements.
- (z) Aesthetics requirements.
- (aa) Constructability requirements.
- (ab) Communication requirements.
- (ac) Applicable codes and standards.

(See Table J-1 in Annex J for an example matrix that can assist in the development of Owner's Project Requirements.)

**5.2.2.5** Obtaining the information and criteria for the Owner's Project Requirements document requires input from all key facility users and operators. The method used to obtain the information should allow the different user groups and operators to interact. Nominal Group Technique workshops, interviews, and surveys can be used to obtain this input, with decreasing levels of interaction attained, respectively, for each type. See Annex I for additional guidance.

**5.2.2.6** The Owner's Project Requirements become part of the Systems Manual documentation.

**5.2.2.7** The Owner's Project Requirements is a document that evolves through each project phase. As decisions are made during the Design, Construction, and Occupancy and Operations Phases, this document will be updated to reflect the current project requirements of the Owner. It is the primary tool for benchmarking success and quality at all phases of the project delivery and throughout the life of the facility.

**5.2.2.8** Make reference to the Owner's Project Requirements in the bidding documents as "information available to bidders." It must be noted in the contract documents that the Owner's Project Requirements are issued for information only and that this document shall not define, nor shall it be used to interpret, the requirements of the contract.

**5.2.2.9** Use quality-based sampling for verification of each activity or task to determine how well it meets or relates to the Owner's Project Requirements in the Pre-Design Phase. This includes programming documents, defined scope-of-design services, special reports and workshop outcomes, and other activities in the Pre-Design Phase.

**5.2.3** Identify the scope and budget for the Commissioning Process

**5.2.3.1** The scope of the Commissioning Process will vary from one project to another. The Commissioning Team develops the scope for the Commissioning Process. The experiences of the programming team, users, designers, Commissioning Authority, and the Owner with similar and previous facilities and projects can aid in establishing a scope for the Commissioning Process. Additional insight regarding the scope of the Commissioning Process can be obtained from code officials, regulations, published information on similar facilities, and information in the Technical Commissioning Process Guidelines.

**5.2.3.2** A well-defined scope permits the establishment of an appropriate budget allocation for the Commissioning Process. The Commissioning Process budget should be realistic, distributed by phase, activity, and entity (Owner, Commissioning Authority, design professional, and contractors), and not subject to reduction without an express change in the Commissioning Plan. Lack of a properly defined and maintained Commissioning Process budget will adversely affect the Commissioning Process and the success of the facility in meeting the Owner's Project Requirements.

**5.2.3.3** Typically the Owner will focus the Commissioning Process efforts on selected systems or assemblies based upon the budget, systems or assemblies where the Owner has experienced previous problems, upon complex systems and assemblies, or upon the criticality of the system or assembly in providing for the Owner's Project Requirements. The Commissioning Process can focus upon:

- (a) Substructure: includes basement and foundations.
- (b) Shell: includes superstructure, roof, walls, fenestration, and exterior doors.
- (c) Interiors: includes interior construction, wall, floor, and ceiling finishes, partitions, interior doors, stairways,

hardware, and fitting specialties.

- (d) Services: includes controls, HVAC&R systems, electrical systems, fire and life safety systems and assemblies, security systems, communication systems, plumbing systems, conveying systems, and specialty or technology systems.
- (e) Equipment and furnishings.
- (f) Sitework.
- (g) Landscaping.

#### **5.2.4 Develop the Commissioning Plan**

**5.2.4.1** The Commissioning Plan identifies processes and procedures necessary for a successful Commissioning Process. The Commissioning Plan addresses the Owner's Project Requirements and reflects the defined scope and budget for the Commissioning Process.

**5.2.4.2** The Commissioning Plan includes a schedule of Commissioning Process activities, individual responsibilities, documentation requirements, communication and reporting protocols, and evaluation procedures. Evaluation procedures include the review and verification to the Owner's Project Requirements of the design documents, contract documents, construction and test procedures.

**5.2.4.3** The Commissioning Plan is continually updated during the life of a project to reflect changes in planning, design, construction, and occupancy and operations. During the Pre-Design Phase, the Commissioning Plan focuses upon the scope of the Commissioning Process during the Design Phase. The Construction Phase and Occupancy and Operations Phases are included, but details are usually added during the Design Phase for the Construction and Occupancy and Operations Phases—see Sections 6.2.3 and 7.2.5.

**5.2.4.4** The Commissioning Plan contains the following information:

- (a) Overview of the Commissioning Process developed specifically for the project.
- (b) Roles and responsibilities for the Commissioning Team throughout the project and specifically during the Pre-Design and Design Phases. The roles shall differentiate the areas with which each of the members is involved, and the responsibilities shall detail the specific tasks that are to be completed by the individual members.
- (c) Documentation of general communication channels to be used throughout the project. Design Phase procedures should be clearly documented during the Pre-Design Phase.
- (d) Detailed description of Commissioning Process activities and a schedule of activities during the Pre-Design and Design Phases. The milestones should include the Commissioning Team meetings, Owner's Project Requirements development, design review periods, and the completion of the Basis of Design and the commissioning specifications.
- (e) General description of Commissioning Process activities that will occur during the Construction and Occupancy and Operations Phases.
- (f) Guidelines and format that will be used to develop the

Commissioning Process documentation that facilitates communication among the Commissioning Team and all other parties involved in the project.

- (g) Commissioning Process forms that will be used during the Pre-Design and Design Phases to communicate and track critical Commissioning Process information.
- (h) Project design document verification procedures.
- (i) The framework for procedures to follow whenever Commissioning Process verification does not meet the Owner's Project Requirements.
- (j) Quality-based sampling procedures for verification of achieving the Owner's Project Requirements during all project phases.

**5.2.4.5** If properly developed, the Commissioning Plan forms the core of the Final Commissioning Process Report.

### **5.2.5 Establish Issues Log Procedures**

**5.2.5.1** An Issues Log contains detailed descriptions of design, installation, or performance issues that are at variance with the Owner's Project Requirements. Issues are identified and tracked as they are encountered during the design, construction, and operation of a facility. It is recommended that an Issues Log be maintained with the status of all current and resolved issues. The information outlined in 5.2.5.2 and 5.2.5.3 should be documented in the Issues Log as a minimum.

**5.2.5.2** Information to be documented at the time an issue is identified includes:

- (a) Unique numeric or alphanumeric identifier by which the issue may be tracked.
- (b) Short, descriptive title of the issue.
- (c) Date and time of the identification of the issue.
- (d) Test number of the test being performed at the time of the observation, if applicable, for cross-reference.
- (e) Identification of system, equipment, or assembly to which the issue applies.
- (f) Location of the issue.
- (g) Description of the observed design, installation, or performance issue, including any information that may be helpful in diagnosing or evaluating the issue.
- (h) Recommended corrective action, if apparent.
- (i) Identification of the Commissioning Team member responsible for resolution of the issue, if apparent.
- (j) Expected date of correction.
- (k) Name of the person documenting the issue.

**5.2.5.3** Information to be documented when an issue is resolved:

- (a) Date of completion of resolution.
- (b) Description of corrective action taken. Include description of diagnostic steps taken to determine the root cause of the issue and the value of resolving the Commissioning Process issue for the owner, design team, contractor, or occupant.
- (c) Identification of changes to the Owner's Project Requirements or Basis of Design that require action (if any).

- (d) Statement that the correction was completed and the system or assembly is ready for retest, if applicable.
- (e) Name of the person who resolved the issue.
- (f) Name of person documenting the issue resolution.

### **5.2.6 Prepare Issues Report**

**5.2.6.1** On a periodic basis, at least for each Commissioning Team meeting, a report shall be generated for review of outstanding issues. The following information should be included:

- (a) Issue number.
- (b) Short, descriptive title of the issue.
- (c) Date of the identification of the issue.
- (d) Name of the Commissioning Team member assigned responsibility for resolution.
- (e) Expected date of correction.

### **5.2.7 Prepare Commissioning Process Progress Reports**

**5.2.7.1** Commissioning Process Progress Reports are periodic reports of the status of Commissioning Process activities throughout the project and become part of the Commissioning Process Report. Commissioning Process Progress Reports should cover the following information:

- (a) Commissioning Process activities completed since the last report, including the current status of Pre-Design project activities.
- (b) Description of changes to the Commissioning Process schedule (e.g., early completion of or delays in work and early or late delivery of items that impact the Commissioning Process activities), Commissioning Plan, and design, along with their effect on the Owner's Project Requirements and Basis of Design.
- (c) Include new and outstanding issues and list those that have been resolved since the last Progress Report, including a brief description of actions taken to resolve the issues. Also include planned activities to resolve outstanding issues expeditiously.
- (d) Commissioning Process activities anticipated during the period before the next Progress Report.

**5.2.7.2** The frequency of Commissioning Process Progress Reports depends upon the amount of work being accomplished and could vary from every two weeks to every six months. A general guide to follow is one progress report for every four Commissioning Team meetings.

### **5.3 Pre-Design Phase Acceptance Requirements**

**5.3.1** During the Pre-Design Phase the Commissioning Process should include the formal acceptance by the Owner of the Owner's Project Requirements and the Commissioning Plan.

### **5.4 Pre-Design Phase Documentation**

**5.4.1** The Commissioning Process scope and budget, Owner's Project Requirements, the Commissioning Plan, Issues Log and reports, and Commissioning Process Progress Reports are the primary documentation requirements for the Pre-Design Phase Commissioning Process.

**5.4.2** The information in the Owner's Project Requirements and the Commissioning Plan is used throughout subsequent project phases (including Occupancy and Operations).

## **5.5 Pre-Design Phase Training Identification Requirements**

**5.5.1** Training requirements for facility, system, and assembly operation and maintenance are addressed in the Owner's Project Requirements.

## **6. DESIGN PHASE**

### **6.1 Introduction**

**6.1.1** During the Design Phase of the project delivery process, the Owner's Project Requirements are translated into construction documents. A document called the Basis of Design is created that clearly conveys the assumptions made in developing a design solution that fulfills the intent and criteria in the Owner's Project Requirements document. Narrative descriptions of facility systems and assemblies are developed and included in the Basis of Design, and the Commissioning Plan is expanded to include the details of Construction and Occupancy and Operations Phase activities.

**6.1.2** Design Phase Commissioning Process objectives include the following:

- (a) Verifying the Basis of Design document with the Owner's Project Requirements document.
- (b) Updating the Commissioning Plan to include Construction and Occupancy and Operations Phase Commissioning Process activities.
- (c) Developing Commissioning Process requirements for inclusion in the Construction Documents.
- (d) Developing draft Construction Checklists.
- (e) Updating the scope and format of the project Systems Manual.
- (f) Defining training requirements.
- (g) Performing commissioning-focused design review.
- (h) Acceptance of Design Phase Commissioning Process activities.

**6.1.3** Design Phase Commissioning Process activities described in this section that are to be performed by the design team and special consultants must be included in the scope of services described in the "Owner - Design Professional Service Agreement." These Commissioning Process activities may be more than are normally required in their scope of services. The scope of services in the "Owner - Design Professional Service Agreement" should also include the requirement to cooperate with the Commissioning Authority during Pre-Design, Design, and Construction phases of the project. This may include testing soils, evaluating or checking existing conditions, surveying, or other requirements during Design.

**6.1.4** Use quality-based sampling for verification of each activity or task determined to be related to the Owner's Project Requirements in the Design Phase.

**6.1.5** If the Commissioning Process on a particular project starts at the Design Phase, then the Commissioning Process

activities described for the Pre-Design Phase must be completed before the following Design Phase activities are begun.

## **6.2 Design-Phase Commissioning Process Activities**

### **6.2.1 Design-Phase Commissioning Process Responsibilities**

**6.2.1.1** During the Design Phase, the Commissioning Team works to verify that the Construction Documents meet and properly convey the Owner's Project Requirements.

**6.2.1.2** Essential team members during the Design Phase include the Owner's representatives, the Commissioning Authority, design professionals, and construction/program/project managers (if known).

**6.2.1.3** Responsibilities of the Commissioning Team during the Design Phase include the following:

- (a) Build and maintain cohesiveness and cooperation among the project team.
- (b) Assist Owner in preparing requests for project services that outline the Commissioning Process roles and responsibilities developed in the Commissioning Plan.
- (c) Verify that Commissioning Process activities are clearly stated in all project scopes of work.
- (d) Develop the scope and budget for project-specific Commissioning Process activities.
- (e) Identify specialists who will be responsible for accomplishing the Commissioning Process activities for specific systems and assemblies.
- (f) Conduct and document Commissioning Team meetings.
- (g) Inform all Commissioning Team members of decisions that result in modifications to the Owner's Project Requirements.
- (h) Integrate the Commissioning Process activities into the project schedule.
- (i) Track and document issues and deviations relating to the Owner's Project Requirements and document resolutions in the Issues Log.
- (j) Verify documentation and updating of the Basis of Design.
- (k) Develop Construction Checklists.
- (l) Develop Construction and Occupancy and Operations Phase test requirements.
- (m) Develop training program requirements.
- (n) Document Commissioning Process requirements and integrate them into the contract documents.
- (o) Update the Commissioning Plan.
- (p) Review Design Phase documents for compliance with the Owner's Project Requirements.
- (q) Update the Owner's Project Requirements.
- (r) Write and review Commissioning Process Progress Reports.

### **6.2.2 Basis of Design Documentation**

**6.2.2.1** The Basis of Design, developed and updated throughout the Design Phase, is required with each design submission and should include the following:

- (a) System and assembly options.

- (b) System and assembly selection reasoning.
- (c) Facility, system, and assembly performance assumptions:
  - (i) Assumptions for calculations/sizing.
  - (ii) Analytical procedures and tools.
  - (iii) Environmental conditions.
  - (iv) Limiting conditions.
  - (v) Reference make and model.
  - (vi) Operational assumptions.
- (d) Narrative system and assembly descriptions.
- (e) Codes, standards, guidelines, regulations, and other references.
- (f) Owner guidelines and directives.
- (g) Specific descriptions of systems and assemblies.
- (h) Consultant, engineering, and architectural guidelines for design developed by the design team or others.

**6.2.2.2** The Basis of Design documents how each criterion in the Owner's Project Requirements is implemented in the design. For any criterion that could not be met, documentation detailing what was done, its impact on the Owner's Project Requirements, and how the Owner's Project Requirements was modified shall be included.

### **6.2.3 Update Commissioning Plan**

**6.2.3.1** The Commissioning Plan must be updated to reflect changes in the Owner's Project Requirements and include additional information developed during the Design Phase.

**6.2.3.2** During the Design Phase, the following is added to or updated in the Commissioning Plan:

- (a) Systems and assemblies to be verified and tested.
- (b) Schedule of Construction Phase and Occupancy and Operations Phase Commissioning Process activities.
- (c) Roles and responsibilities of new Commissioning Team members.
- (d) Construction Phase and Occupancy and Operations Phase documentation and reporting requirements, including procedures and formats.
- (e) Construction Phase and Occupancy and Operations Phase communication protocols.
- (f) Construction Phase and Occupancy and Operations Phase Commissioning Process procedures.

**6.2.3.3** The milestones to be incorporated in the schedule should include the pre-bid meeting, pre-construction meeting, Commissioning Team meetings, training sessions, shop drawing submittals, Systems Manual submittal, special tests or code official inspection and acceptance, tests, test periods, substantial completion, occupancy, seasonal testing, initial Commissioning Process Report submittal, warranty review two months prior to end of warranty period, lessons-learned meeting, and final Commissioning Process Report.

**6.2.3.4** The Construction Phase and Occupancy and Operations Phase roles and responsibilities of the individual members of the Commissioning Team, including any new members, should be clearly defined based upon the unique experience and knowledge of the team members. Professional

and services agreements must be modified to reflect the scope of work.

**6.2.3.5** The Commissioning Plan must define the documentation that will be required as part of the Commissioning Process during the Construction Phase and Occupancy and Operations Phase. This includes the specific formats to be used (electronic/paper, software program and version), the information to be included, the frequency of submittal, and the distribution.

**6.2.3.6** The communication protocols to be used during the Construction Phase and Occupancy and Operations Phase shall be clearly defined in the Commissioning Plan. This includes how the flow of information among the team members will be coordinated and distributed.

**6.2.3.7** The Commissioning Process procedures to be implemented during the Construction Phase and Occupancy and Operations Phase must be clearly documented in the Commissioning Plan. These include:

- (a) Review of submittals.
- (b) Scheduling and holding of meetings.
- (c) Site visit procedures.
- (d) Issues identification, documentation, tracking, and resolution.
- (e) Construction Phase test preparation, implementation, and follow-up.
- (f) The responsibilities of each member of the Commissioning Team.
- (g) Who is responsible for costs related to verification and testing—including re-testing or verification activities.
- (h) Systems Manual development and review.
- (i) Training program.
- (j) Occupancy and Operations Phase test preparation, implementation, and follow-up.

**6.2.3.8** The test procedure requirements developed during the Design Phase are general in nature, structure, and complexity but must clearly convey the level and amount of testing (see Section 7.2.9) required by manufacturers and contractors.

### **6.2.4 Commissioning Process Requirements in the Construction Documents**

**6.2.4.1** The Commissioning Process requires that certain quality-assurance and quality-control procedures, envisioned in the Commissioning Plan, be performed as part of the construction contract.

**6.2.4.2** The Owner's Project Requirements should be included in the Contract Documents and labeled as for "Informational Purposes Only" to differentiate it from the contractor's contractual obligations. In addition, as much Basis of Design information should be included in the Contract Documents as possible. This information is included in the Contract Documents to aid the contractors in understanding the design, material requirements, sustainability and energy goals, and the desired use and intent of the facility. Such information aids in the successful implementation of the Commissioning Process but does not relate directly to the contract requirements.

**6.2.4.3** Specific Commissioning Process requirements are included in the contract specifications. For this guideline, specification division numbers and section titles consistent with the Construction Specifications Institute MasterFormat® are used. This is done to simplify a lengthy list of specification requirements. Commissioning Process activities that address systems and assemblies need to be included in Division 1 sections and those that address equipment and components need to be included in Divisions 2 through 16.

- (a) The obligations to perform Commissioning Process activities must be documented in the contract between the Owner and Contractor.
- (b) Detailed scope and responsibilities of the Contractor shall be included in the “Summary of Work” section in Division 1.
- (c) The Commissioning Process requirements for documentation, training, and testing facility systems and assemblies are integrated into commissioning sections in Division 1.
- (d) Specific equipment and component performance documentation requirements and use of Construction Checklists should be integrated into specification sections in Divisions 2 through 16, with appropriate cross-references.

**6.2.4.4** The Commissioning Process activities to be integrated include:

- (a) Performance, installation, and operations information requirements as part of shop drawing submittals in Divisions 2 through 16 sections.
- (b) Completion of Construction Checklists in Division 1 and references to Division 1 in Divisions 2 through 16 sections.
- (c) Contractor involvement in the Commissioning Team in Division 1.
- (d) Test requirements in Division 1.
- (e) Training program development and implementation requirements in Division 1.
- (f) Systems Manual requirements in Division 1.

**6.2.4.5** A guide specification section template for general Commissioning Process requirements in Division 1 is included in Annex L.

## **6.2.5 Construction Checklists**

**6.2.5.1** Construction Checklists aid the installers by providing specific information on the Owner’s Project Requirements for equipment and assemblies for long-term operation. Checklists typically include:

- (a) Equipment/assembly verification.
- (b) Pre-installation checks.
- (c) Installation checks.
- (d) Any negative responses.

**6.2.5.2** The first section of the Checklist is equipment/assembly verification. This section should include vital information on the equipment or materials being supplied (specific listings of vital information are included in the technical guidelines developed for various facility systems). This section contains information on what equipment/material was

specified/submitted and space to document/verify what was actually delivered to the site.

**6.2.5.3** The pre-installation section of the Checklist is utilized to verify the condition of the equipment/material at the site immediately prior to its installation.

**6.2.5.4** The installation section of the Checklist is utilized to verify proper installation. This section focuses on the ability of the installation to meet the Construction Documents and the Owner’s Project Requirements. For equipment, this section focuses on the physical installation and its start-up when applicable. For assemblies, the focus is typically on installation and performance.

**6.2.5.5** The negative responses section is a space provided to document the reason for any negative responses and whether any action has been taken to correct the problem or problems that led to the negative responses.

**6.2.5.6** Whenever a test data form is required for a specific system or assembly, there should be an item in the associated Construction Checklist for the test data form to be submitted to the Commissioning Authority.

**6.2.5.7** Construction Checklists should be kept as short as possible and the questions should be worded clearly so that the correct answer is typically yes.

**6.2.5.8** Construction Checklists are used by the Commissioning Team to verify that the installation meets the Owner’s Project Requirements. They can also be used by the contractors to track progress of construction against the schedule of values.

**6.2.5.9** Annex M contains sample formats for Construction Checklists.

## **6.2.6 Systems Manual**

**6.2.6.1** The Systems Manual should provide the information needed to understand, operate, and maintain the systems and assemblies and to inform those not involved in the design and construction process about the systems and assemblies. The Systems Manual should be the repository of information on updates and corrections to systems and assemblies as they occur during the Occupancy and Operations Phase.

**6.2.6.2** The Systems Manual expands the scope of the traditional operating and maintenance documentation to include the additional information gathered during the Commissioning Process and to provide a systems-based organization of information.

**6.2.6.3** Contractor documentation requirements for the Systems Manual shall be clearly stated in the Construction Documents.

**6.2.6.4** The following should be included in the Systems Manual (see Annex O for an example format):

- (a) Index of Systems Manual with notation as to content storage location if not in actual manual.
- (b) Executive Summary.
- (c) Owner’s Project Requirements.
- (d) Basis of Design documents.
- (e) Construction Record Documents, specifications, and approved submittals.
- (f) A list of recommended operational record-keeping pro-

cedures, including sample forms, logs, or other means, and a rationale for each.

- (g) Ongoing optimization guidance.
- (h) Operations and maintenance manuals (includes operating procedures for all normal, abnormal, and emergency modes of operation; maintenance procedures; parts and recommended spare parts list; troubleshooting guide; and systems schematics (one-line diagrams).
- (i) Training materials.
- (j) Commissioning Process Report.

### **6.2.7 Training Requirements**

**6.2.7.1** During the Design Phase, the training requirements of the operations and maintenance personnel and occupants are identified relative to the systems and assemblies to be installed in the facility. It is critical that the operations and maintenance personnel have the knowledge and skills required to operate the facility to meet the Owner's Project Requirements. The occupants need to understand their impact on the use of the facility and its ability to meet the Owner's Project Requirements.

**6.2.7.2** These training requirements can be obtained using a Nominal Group Technique workshop, interviews, or surveys. The requirements are obtained after the systems and assemblies have been decided upon, and prior to issuance of the Construction Documents, to ensure that the requirements for training are clearly conveyed in the Construction Documents. The results of the workshop, interviews, or surveys should address the following:

- (a) The systems, subsystems, equipment, and assemblies for which training will be required.
- (b) The capabilities and knowledge of the occupants and operations and maintenance personnel.
- (c) The number and type of training sessions. The training program should be organized into a series of instructional modules, each covering a portion of the facility's systems, equipment, and assemblies.
- (d) Measurable learning objectives and teaching outlines should be developed to clearly describe the specific skills and knowledge that the participant is expected to master.

**6.2.7.3** The first training session should be general in nature for the operations and maintenance personnel and the occupants, and it should review the Owner's Project Requirements and the Basis of Design. This provides the background on why the facility is being constructed and its limitations.

**6.2.7.4** The majority of training should be planned to be accomplished during the Construction Phase and prior to substantial completion.

**6.2.7.5** Training during the Occupancy and Operations Phase may be required for certain systems and assemblies to achieve or maintain the Owner's Project Requirements.

**6.2.7.6** The Systems Manual has a close functional relationship with personnel training. A meaningful and useful training program typically includes using the operation and maintenance components of the Systems Manual as the basis of development.

**6.2.7.7** Review of documentation during training consists of reviewing the content of emergency, operation, and maintenance information in the Systems Manual, project Record Documents, system and equipment identification systems, warranties, and maintenance service agreements contained in the Systems Manual. Training should specifically address:

- (a) Emergency instructions and procedures: those required for operating the facility during various emergencies, including step-by-step instructions for each type of emergency.
- (b) Operation instructions and procedures: the procedures required for normal operation of the facility, including step-by-step instructions for day-to-day operation.
- (c) Adjustment instructions: information for maintaining operational parameters.
- (d) Troubleshooting procedures: instructions for diagnosing operating problems and procedures for testing and inspecting.
- (e) Maintenance and inspection procedures.
- (f) Repair procedures: instructions for diagnosing problems and for disassembly, component removal, replacement, and reassembly.
- (g) Upkeep of the Systems Manual and associated maintenance documentation and logs.

**6.2.7.8** In the specifications, as a minimum, define the time requirements for each type of system/assembly that requires demonstration and training or include an allowance for demonstration and training capabilities. Also include the expected experience and knowledge of trainer, the number of unique training sessions, the need for repeating the training for multiple shifts, and submittal of Training Plan, handouts, record of the training, and electronic recording of on-site training.

**6.2.7.9** Training materials should include or utilize the following items:

- (a) Copy of the Training Plan including schedule, syllabus, and agenda.
- (b) Systems Manual.
- (c) Manufacturers' training manuals.
- (d) Electronic media or videotapes of manufacturers' or vendors' training and service materials.

### **6.2.8 Review of Design Professional Submittals**

**6.2.8.1** Complete targeted design reviews at strategic times during the Design Phase. All design issues should be resolved prior to continuing with design.

**6.2.8.2** A targeted design review is composed of four tasks:

- (a) General quality review of the documents, including legibility, consistency, and level of completeness.
- (b) Coordination between disciplines.
- (c) Discipline-specific review for achieving the Owner's Project Requirements.
- (d) Specification applicability and consistency with Owner's Project Requirements and Basis of Design.

**6.2.8.3** The general quality of the documents is evaluated by checking for consistent layout and legibility of the Design Professional Submittal and Construction Documents. Compliance with the Owner's Project Requirements along with ease of use and clarity are the major issues to check when looking at the complete package. This review looks for completeness of the drawings and for items of concern identified during previous reviews.

**6.2.8.4** Sample areas of the facility, 10-20% of the total area, are reviewed in detail to evaluate the coordination accomplished within and among disciplines. This includes reviewing for constructability and interfaces among disciplines. The intent of this review is to determine if there are systematic errors, not to fully check the drawings. The responsibility for complete checking of the drawings for coordination and accuracy remains with the Design Team.

**6.2.8.5** A discipline-specific review involves a review of the Construction Documents along with the Basis of Design, design calculation assumptions, and methods for compliance with the Owner's Project Requirements. A sampling strategy of focusing upon 10-20% of the drawings provides for an in-depth analysis and evaluation of the ability of the documents to meet the Owner's Project Requirements.

**6.2.8.6** A review of the specifications is performed to determine completeness and applicability to the project. A review of 10-20% of the specification is performed in detail for verification of compliance with the Owner's Project Requirements. Items checked include applicability of the section to the project, Commissioning Process requirements, submittal requirements, applicability of equipment, training requirements, and coordination with other sections.

**6.2.8.7** See Annex N for additional guidance on how to accomplish quality-based design reviews.

### **6.3 Design Phase Acceptance Requirements**

**6.3.1** The Commissioning Process should include the formal acceptance by the Owner of the Basis of Design and the updated Owner's Project Requirements during the Design Phase, following review and comment by the Commissioning Authority.

### **6.4 Design Phase Documentation Requirements**

**6.4.1** Construction Document commissioning requirements, updated Owner's Project Requirements, updated Commissioning Plan, the updated Issues Log, and the Commissioning Process Progress Reports are the primary documentation requirements for the Design Phase Commissioning Process.

**6.4.2** The information in these deliverables is used throughout subsequent project phases (including Occupancy and Operations).

### **6.5 Design Phase Training Identification Requirements**

**6.5.1** Training requirements for facility, system, and assembly operation and maintenance are addressed during the Design Phase by the completion of a training requirements identification workshop, development of the Construction Phase and Occupancy and Operations Phase training pro-

gram, and inclusion of the training program requirements in the Commissioning Plan and Construction Documents.

## **7. CONSTRUCTION PHASE**

### **7.1 Introduction**

**7.1.1** During the Construction Phase of the project delivery process, systems and assemblies are installed, inspected, tested, and placed into service to meet the Owner's Project Requirements. This phase may also include bidding, negotiation, and contracting activities. The Systems Manual is delivered during this phase and training is provided.

**7.1.2** Construction Phase Commissioning Process objectives include the following:

- (a) Updating the Owner's Project Requirements.
- (b) Updating the Commissioning Plan.
- (c) Verifying that submittals meet the Owner's Project Requirements.
- (d) Developing detailed test procedures and data forms.
- (e) Verifying that systems and assemblies comply with the Owner's Project Requirements.
- (f) Delivering the Systems Manual.
- (g) Verifying training of the Owner's operation and maintenance personnel and occupants.
- (h) Acceptance of Construction Phase Commissioning Process activities.

**7.1.3** Construction Phase Commissioning Process activities described in this section that are to be performed by the design team and special consultants must be included in the scope of services described in the "Owner – Design Professional Service Agreement." These Commissioning Process activities may be more than are normally required in their scope of services. The scope of services in the "Owner - Design Professional Service Agreement" should also include the requirement to cooperate with the Commissioning Authority during Pre-Design, Design, and Construction phases of the project. This may include material testing, TAB, performance tests, records, photography, outside training, Owner's furnished equipment vendors, and other requirements during the Construction Phase.

**7.1.4** If the Commissioning Process on a particular project starts at the Construction Phase, Commissioning Process activities described for the Pre-Design and Design Phases must be completed before the following Construction Phase activities are begun.

### **7.2 Construction Phase Commissioning Process Activities**

#### **7.2.1 Construction Phase Commissioning Process Responsibilities**

**7.2.1.1** During the Construction Phase, the Commissioning Team works to verify that systems and assemblies are installed in a manner that will achieve the Owner's Project Requirements.

**7.2.1.2** Use quality-based sampling for verification of each task and test determined to be related to the Owner's Project Requirements during the Construction Phase.

**7.2.1.3** Conduct and document regularly scheduled Commissioning Team meetings to facilitate coordination and cooperation in delivering a facility that meets the Owner's Project Requirements.

**7.2.1.4** Essential team members during the Construction Phase include Owner's representatives, the Commissioning Authority, design professionals, contractors, suppliers/vendors, and construction/program/project managers.

**7.2.1.5** Responsibilities of the Commissioning Team during the Construction Phase include the following:

- (a) Participate in the pre-bid conference.
- (b) Coordinate participation of Owner's representatives.
- (c) Identify specialists who will be responsible for accomplishing the Commissioning Process activities for specific systems and assemblies.
- (d) Update the Owner's Project Requirements to reflect decisions made during bidding and construction.
- (e) Update the Commissioning Plan.
- (f) Conduct a pre-construction Commissioning Process meeting.
- (g) Review the following submittals for compliance with the Owner's Project Requirements: coordination drawings, shop drawings, product data, preliminary Systems Manual, and training program.
- (h) Schedule the Commissioning Process activities and integrate them into the project construction schedule.
- (i) Address schedule changes.
- (j) Develop and document test procedures and data forms.
- (k) Conduct and document ongoing Commissioning Team meetings.
- (l) Monitor compliance with the Owner's Project Requirements through periodic site visits.
- (m) Verify completion of items indicated in the Construction Checklists.
- (n) Witness tests.
- (o) Verify tests.
- (p) Verify test data reports.
- (q) Verify training of operation and maintenance personnel and occupants according to the Owner's Project Requirements.
- (r) Identify, diagnose, and track issues and deviations relating to the Owner's Project Requirements and document resolution of same.
- (s) Write and review Commissioning Process Progress Reports.
- (t) Review construction progress reports.
- (u) Verify incorporation of new equipment and systems into the maintenance management program.
- (v) Verify updates to the Basis of Design documentation.
- (w) Verify updates to the Systems Manual.
- (x) All Commissioning Team members are responsible for keeping the Commissioning Team informed of decisions that result in modifications to the Owner's Project Requirements.

- (y) Review contract modifications for compliance with Owner's Project Requirements.

## **7.2.2 Pre-bid Conference**

**7.2.2.1** Time should be allotted during the pre-bid conference for the Commissioning Team to alert bidders to Commissioning Process requirements with which they may not be familiar.

## **7.2.3 Coordinate Owner's Representatives Participation**

**7.2.3.1** Coordinate and schedule participation of Owner's representatives in Commissioning Process activities. Owner representatives may vary from one activity to another, both in number and in the specific individuals. It is important for Owner's representatives to participate in Commissioning Team meetings, review of commissioning process reports, discussions of changes to the Owner's Project Requirements, and staff and occupant training. Other Commissioning Process activities in which Owner's representatives typically participate include reviewing submittals and witnessing testing.

## **7.2.4 Update Owner's Project Requirements**

**7.2.4.1** Changes to the Owner's Project Requirements during bidding and the Construction Phase may be initiated as the result of Owner-directed changes to the Owner's Project Requirements or design/construction process-initiated changes to the Construction Documents.

**7.2.4.2** When the Owner initiates a change to the Owner's Project Requirements, the design shall be modified and reviewed as necessary to meet the change in the Owner's Project Requirements.

**7.2.4.3** When the Owner considers changes initiated through the design/construction process, the Commissioning Team should review the proposed changes to determine if they compromise the Owner's Project Requirements, paying special attention to the functional impacts of value management proposals. If the Owner chooses to initiate a change after reviewing the Commissioning Team's comments, the Owner's Project Requirements must be updated as necessary to match the change.

## **7.2.5 Update the Commissioning Plan**

**7.2.5.1** Update the Commissioning Plan to include new or revised descriptions of Commissioning Process activities during the Construction Phase. Incorporate the following:

- (a) Test procedures and data forms developed during the Construction Phase.
- (b) Refinement and integration of Commissioning Process activities in the construction schedule.
- (c) Roles and responsibilities of the Commissioning Team during the Construction Phase, including the identification of new team members.
- (d) Identification of specialists responsible for accomplishing Commissioning Process activities for specific systems and assemblies.
- (e) Changes to the communication channels and procedures to be used during the Construction Phase.

## **7.2.6 Conduct Pre-Construction Commissioning Process Meeting**

**7.2.6.1** Early in the Construction Phase, the Commissioning Authority shall conduct a pre-construction Commissioning Process meeting with the Commissioning Team.

**7.2.6.2** During the pre-construction meeting, the Owner's Project Requirements, Basis of Design, and unique contract document requirements are reviewed. In addition, the specific roles and responsibilities of the contractors relative to the Commissioning Process activities are reviewed.

### **7.2.7 Verify Submittals**

**7.2.7.1** It is recommended that a sampling strategy of randomly selecting 5% to 10% of the submittal be used to focus upon the quality and ability of the submittal to achieve the Owner's Project Requirements. If deviations are substantial, then review an additional 5% to 10%. If substantial deviations still exist, then reject the submittal and return it with comments.

**7.2.7.2** Concurrent with Design Team and Owner review, a designated Commissioning Team member reviews coordination drawings, shop drawings, and project submittals for compliance with the Owner's Project Requirements. Special attention must be paid to substitutions and proposed deviations from the Contract Documents and the Basis of Design that could adversely impact the Owner's Project Requirements.

**7.2.7.3** Upon receipt, designated members of the Commissioning Team shall review the Systems Manual for compliance with the Contract Documents and the Owner's Project Requirements.

**7.2.7.4** Review training program, materials, and schedule, and monitor delivery of training to verify that it meets the Owner's Project Requirements for the preparation of operations and maintenance personnel.

**7.2.7.5** Training records are reviewed by designated members of the Commissioning Team for proper documentation of attendees, material covered, and associated details.

### **7.2.8 Schedule Commissioning Process Activities**

**7.2.8.1** The objective of scheduling Commissioning Process activities is to integrate and coordinate them with other Construction Phase activities and to allow all Commissioning Team members to plan their work to achieve the Owner's Project Requirements. Commissioning Process activities should be integrated into the construction schedule. Detailed integration of commissioning work with the construction schedule is critical to maintaining project schedule milestones.

**7.2.8.2** The project schedule needs to include the start date, duration, description, and entity responsible for completion.

**7.2.8.3** As a minimum, the following should be included in the project schedule:

- (a) Commissioning Team meetings.
- (b) Start and completion of each construction phase.
- (c) Key system and assembly completion and tests.
- (d) Training sessions.
- (e) Substantial completion.
- (f) Warranty start date.

(g) Occupant move-in.

(h) Warranty review two months prior to end of warranty period.

(i) Lessons-learned meeting.

### **7.2.9 Develop Test Procedures**

**7.2.9.1** Test Procedures define the means and methods to carry out the tests that are accomplished during the Construction Phase. Test Procedures provide the following:

- (a) Participants required for the test, which may include the primary contractor, secondary contractors, design professionals, the Commissioning Authority, operators, the local authority having jurisdiction, and manufacturers associated with the equipment, system, or assembly.
- (b) Prerequisites for the test performance in terms of completion of systems and assemblies and acceptable completion of other activities.
- (c) Step-by-step instructions to exercise the specific systems and assemblies under test. Instructions include how to configure the system or assembly to start the test and how to restore the system to normal operation at the conclusion of the test.
- (d) List of instrumentation, tools, and supplies required for the test. The list should indicate which of the participants is responsible for each of the items listed. The list should be specific as to make, model, range, capacity, accuracy, calibration, and other pertinent performance requirements.
- (e) An indication, for each step of the procedure, of what observations or measurements must be recorded and the range of acceptable results.

**7.2.9.2** The Commissioning Team will develop a range of test verification procedures. These procedures include:

- (a) Component test procedures: Component test procedures verify the performance of components under a full range of actions, responses to inputs, and loads.
- (b) System/assembly test procedures: System/assembly test procedures verify the performance of subsystems, systems, and assemblies under a full range of operating conditions (both normal and emergency), responses to inputs, and loads.
- (c) Intersystem test procedures: Intersystem test procedures verify the interactions between systems and assemblies.
- (d) Owner's Project Requirements test procedures: Owner's Project Requirements test procedures verify that the various systems and assemblies that comprise the facility deliver the intended Owner's Project Requirements at the point of use.
- (e) Use quality-based sampling for verification of each test determined to be related to the Owner's Project Requirements.

**7.2.9.3** In developing the Test Procedures, special attention must be paid to issues of personnel safety, equipment/assembly protection, and manufacturer's recommendations to protect the validity of the warranty.

### 7.2.10 Develop Test Data Records

**7.2.10.1** Test Data Records capture test data, observations, and measurements. Data may be recorded on photographs, forms, or other means appropriate for the application. The following minimum information should be recorded:

- (a) Test number.
- (b) Date and time of the test.
- (c) Indication of whether the record is for a first test or retest following correction of a problem or issue.
- (d) Identification of the system, equipment, or assembly under test. List the location and the construction document designation.
- (e) Conditions under which the test was conducted. For example, when testing, fully describe the ambient conditions, setpoints, overrides, and the status and operating condition of devices, systems, and equipment that impact the results of the test.
- (f) Expected performance of the systems and assemblies at each step of the test.
- (g) Observed performance of the system, equipment, or assembly at each step of the test. When data forms are used, check boxes generally do not adequately describe the system performance and therefore should be avoided in most cases. A blank space in which the observed or measured performance may be described provides more information for diagnostics and a future baseline for performance.
- (h) Notation to indicate whether the observed performance at each step meets the expected results.
- (i) Other observations about system performance or test procedure.
- (j) Issue number, if any, generated as a result of the test.
- (k) Dated signatures of the person performing the test and of the witness, if applicable.

### 7.2.11 Commissioning Team Meetings

**7.2.11.1** Consistent, periodic Commissioning Team meetings are essential to maintaining the progress of the project.

**7.2.11.2** The schedule of meetings should be documented as early as possible during the Construction Phase and updated as required due to schedule changes. The meeting dates and times should be known a minimum of two weeks in advance and should be coordinated with other meetings to minimize travel time and costs for various attendees.

**7.2.11.3** Team members represented at the meeting must be authorized to make commitments and decisions for their respective organizations to facilitate an effective Commissioning Team meeting.

**7.2.11.4** Prior to a meeting (usually a minimum of three days) an agenda should be distributed to all invited attendees. The agenda should include:

- (a) Meeting location.
- (b) Start time.
- (c) List of invited attendees.
- (d) List of items to cover (previous action items, outstanding

ing issues, schedule review, new issues, and other business) along with defined time allotments for each item.

- (e) End time.
- (f) Attachments, if applicable.

**7.2.11.5** The meeting time and duration should be strictly adhered to. This will set the tone for other Commissioning Process activities.

**7.2.11.6** Within a reasonable and established period (frequently, three days) after the meeting, distribute meeting notes or minutes. This should include:

- (a) Date, time, and location of the meeting.
- (b) List of attendees.
- (c) Resolved action items and issues.
- (d) Outstanding action items and issues, including clear identification of the responsible party and due dates.
- (e) Date, time, and location of the next meeting.

### 7.2.12 Accomplish Periodic Site Visits to Verify Compliance with the Owner's Project Requirements

**7.2.12.1** Site visits are the primary method used during the Construction Phase to verify that the installed systems and assemblies comply with the Owner's Project Requirements.

**7.2.12.2** A clear, concise, and consistent procedure must be followed for each site visit to properly identify Construction Phase process problems and issues.

**7.2.12.3** The site visit procedure uses statistical sampling techniques for verification of the Construction Checklists and Record Documents. This provides assurance that the verification process is not biased and has reliable consistency. The recommended procedure has the following general steps:

- (a) Identify the current state of construction to define the scope of systems and assemblies that can be verified.
- (b) Randomly select between 2% and 10% of the systems and assemblies for verification. This can be accomplished by randomly selecting a starting point and selecting every tenth item from a list or by automatically generating a random sample from a computerized database.
- (c) Identify Commissioning Team members for the site visit.
- (d) Review Owner's Project Requirements.
- (e) Accomplish verification. This task is completed by going to the selected system or assembly and comparing the installation to the completed (full or partial) Construction Checklists. Any negative responses should be reviewed in detail.
- (f) Any consistent problems with the installation identified (typically more than 10% of the sample has the same issue), including Record Documents, are documented in general terms and provided to the contractor for resolution. The contractor is then responsible for 100% checking of all affected systems or assemblies and making corrections as required.
- (g) Any inconsistent problems (one or two occurrences) are sent to the contractor, detailing the specific component, system, or assembly for resolution.

- (h) Meet with contractors to discuss any issues identified and the general progress of the project.
- (i) Meet with the Owner's representative to review the findings, project schedule, and outstanding issues.
- (j) Develop a site visit report and distribute to the Commissioning Team members and other interested parties.
- (k) Update the Issues Log.

#### **7.2.13 Test Execution**

**7.2.13.1** During test execution there can be witnessing of tests, verification of tests, or verification of test data reports. Typically, only one of these is performed by the Commissioning Authority for a specific test or series of tests. However, depending upon the type and complexity of the test, it is possible in some cases to witness a portion of the test, verify the test through a random sampling of components, and verify the test data report through random sampling of the reported results.

**7.2.13.2** Completion of tests should comply with the following:

- (a) Tests shall be performed according to approved written procedures. Results of test performance shall be recorded on the test data forms and witnessed.
- (b) Deviations from the approved procedures, if permitted, should be documented in writing.
- (c) Test data should be recorded under steady-state and stable conditions.
- (d) If an issue is observed during a test, the test should be terminated, within the scope of the contract. An issue report is created at the time of observation. If the issue cannot be resolved within a reasonable time period, it may be required to run the test immediately, with the understood options to run the test later, after all issues are resolved.
- (e) If an issue is discovered during review of the data, the issues shall be resolved or the test repeated in its entirety.
- (f) Upon completion of the test, the technician performing the test and the witnesses sign the test data record, attesting to the verity of the recorded observations.

**7.2.13.3** Generally, the sequence of testing will be executed in the order of activities listed:

- (a) The verification of the Construction Checklists begins with equipment or assembly delivery and continues through start-up and testing.
- (b) Tests verifying system and intersystem performance according to the Owner's Project Requirements cannot begin until the Construction Checklists have been verified and accepted by the Commissioning Team.
- (c) Other sequencing requirements, depending upon the specific system, may be required to ensure the proper conditions are present or can be created.
- (d) A specified test is run according to Contract Documents or to manufacturer's requirements.

#### **7.2.14 Verify Training**

**7.2.14.1** Within a reasonable period (such as three weeks) of each training program, between 5% and 10% of the

trainees shall be randomly selected and tested or informally evaluated on the material covered in the specific program. The intent of this testing is to verify that the trainees were provided with the pertinent information to operate and maintain the facility according to the Owner's Project Requirements.

**7.2.14.2** It is not typically expected that the trainees will have memorized everything from the training session but that they know where the information is, can find it, and understand sufficiently to walk through the key steps to troubleshoot a problem and resolve it.

**7.2.14.3** Attendee sign-in sheets should be used to verify that training was delivered to the intended people.

#### **7.2.15 Construction Phase Commissioning Process Report**

**7.2.15.1** The Construction Phase Commissioning Process Report is the documentation of the commissioning work and results accomplished during the Construction Phase. The Construction Phase Commissioning Process Report contains the following:

- (a) Identification of any systems or assemblies that do not perform in accordance with the Owner's Project Requirements. For various reasons, the Owner may choose to accept performance that is at variance with the Owner's Project Requirements, either permanently or until schedule and budget constraints allow for correction. The Owner's acceptance of these conditions should be documented along with the environmental, health, safety, comfort, energy, and operating and maintenance cost impacts. The Owner's Project Requirements must be updated to match the revised expectations.
- (b) Evaluations of the operating condition of the systems at the time of test completion.
- (c) Construction Checklist completion and verification summary.
- (d) Results from the Issues Log, including the descriptions of issues and the measures taken to correct them. The description should assess the importance of the issues and estimate the value of their correction in terms of environmental impact, improved health, safety, comfort, energy consumption, operating and maintenance costs, and the ability of the facility to support its mission.
- (e) Test procedures and data. This section should incorporate the original test procedures and signed data forms, including additional data such as photos, computerized documentation, and other records of the tests. Data should include the final accepted test, as well as earlier tests that failed to meet the specified criteria. This section should also include a set of blank data forms for future use in the Continuous Commissioning Process and Re-commissioning.
- (f) Commissioning Process Progress Reports. Copies of progress reports generated throughout the Commissioning Process.
- (g) Deferred Tests. Execution of some tests may be deferred until appropriate natural loads, such as occupancy or design weather conditions, are available. For these deferred tests, the prerequisite conditions and an estimated schedule for their completion should be included.

- (h) Lessons Learned. Evaluation of the Commissioning Process used and changes that will improve the delivered project and form the basis for the Final Commissioning Process Report developed during the Occupancy and Operations Phase. This is essential to ensure that issues, benefits, and recommendations are captured in a written document while all team members are available and information is fresh.

**7.2.15.2** A draft Construction Phase Commissioning Process Report should be submitted for Owner review. Submittal of the draft Commissioning Process Report to other Commissioning Team members may also be appropriate.

**7.2.15.3** The final Construction Phase Commissioning Process Report should incorporate review comments from the Owner and, optionally, from other Commissioning Team members.

#### **7.2.16 Verify Systems Manual Update**

**7.2.16.1** Verify that the Systems Manual is updated to incorporate materials generated during the Construction Phase. Materials that should be added are:

- (a) Test procedures and test data records.
- (b) Training plans.
- (c) Training records.
- (d) Record Drawings.
- (e) Submittal review reports.
- (f) Updated Owner's Project Requirements.
- (g) Updated Basis of Design.
- (h) Updated Commissioning Plan.
- (i) Updated Issues Log.
- (j) Commissioning Process Progress Reports.

#### **7.2.17 Verify Update of the Basis of Design**

**7.2.17.1** Verify that the Basis of Design is updated to reflect any changes to the design during the Construction Phase. Verify that design changes comply with the Owner's Project Requirements. If necessary, update the Owner's Project Requirements.

### **7.3 Construction Phase Acceptance Requirements**

**7.3.1** The Commissioning Process should include the formal acceptance by the Owner of the Systems Manual, verified test reports, and training reports, consistent with the recommendations of the Commissioning Authority and appropriate other Commissioning Team members.

### **7.4 Construction Phase Documentation Requirements**

**7.4.1** The primary Commissioning Process requirements for documentation during the Construction Phase include the Construction Phase Commissioning Process Report and commissioning elements of the Systems Manual.

**7.4.2** The information in these deliverables is used throughout the Occupancy and Operations Phase.

### **7.5 Construction Phase Training Requirements**

**7.5.1** The Commissioning Process training requirements for the Construction Phase are discussed in Section 7.2.14.

## **8. OCCUPANCY AND OPERATIONS PHASE**

### **8.1 Introduction**

**8.1.1** The Occupancy and Operations Phase of the Commissioning Process begins at substantial completion. As a minimum, the Commissioning Process activities begun at this point should continue through the end of the contractual warranty/correction period and ideally continue throughout the life of the facility. During the Occupancy and Operations Phase, the ongoing operation, maintenance, and modification of the facility systems and assemblies, and their associated documentation, are verified against the updated Owner's Project Requirements.

**8.1.2** The active involvement of the Commissioning Authority and Commissioning Team during the initial portion of the Occupancy and Operations Phase of a project is an integral aspect of the Commissioning Process.

**8.1.3** Occupancy and Operations Phase Commissioning Process objectives include the following:

- (a) Using the Commissioning Authority's project knowledge and experience to minimize contractor callbacks.
- (b) Providing ongoing guidance on operations and maintenance to achieve the Owner's Project Requirements.
- (c) Completing seasonal testing of facility systems and assemblies.
- (d) Documenting lessons learned from applying the Commissioning Process for application to the next project.
- (e) Acceptance of Occupancy and Operations Phase Commissioning Process activities.

**8.1.4** Occupancy and Operations Phase Commissioning Process activities described in this section that are to be performed by the design team and special consultants that must be included in the scope of services described in the "Owner – Design Professional Service Agreement." These Commissioning Process activities may be more than are normally required in their scope of services. The scope of services in the "Owner - Design Professional Service Agreement" should also include the requirement to cooperate with the Commissioning Authority during Pre-Design, Design, and Construction Phases of the project. This may include training, seasonal tests, problem resolution, design evaluation, site visits, updating drawings and specifications, or other requirements performed during the occupancy and initial operations period defined for the project.

**8.1.5** If the Owner adopts the Commissioning Process on a project at the Occupancy and Operations Phase, then this process is termed "Retro-Commissioning" and, while it accomplishes some Commissioning Process Activities described herein, it is sufficiently different from the Commissioning Process that it is not within the scope of this guideline.

**8.1.6** It is often desirable for the Owner to maintain the benefits of the Commissioning Process well into the life of the facility.

### **8.2 Occupancy and Operations Phase Commissioning Process Activities**

#### **8.2.1 Occupancy and Operations Phase Commissioning Process Responsibilities**

**8.2.1.1** During the Occupancy and Operations Phase, the Commissioning Team works to verify the ongoing compliance with the Owner's Project Requirements.

**8.2.1.2** Essential team members during the Occupancy and Operations Phase include Owner's representatives, the Commissioning Authority, design professionals, contractors, and construction/program/project managers.

**8.2.1.3** Responsibilities of the Commissioning Team during the Occupancy and Operations Phase include the following:

- (a) Coordinate contractor callbacks.
- (b) Verify seasonal testing of facility systems and assemblies.
- (c) Verify continuing operation and maintenance personnel training.
- (d) Verify system and assembly operations meet updated Owner's Project Requirements.
- (e) Verify continual updating of the Systems Manual.
- (f) Conduct and verify periodic performance evaluations of facility systems and assemblies.
- (g) Convene lessons-learned workshop.
- (h) Complete the final Commissioning Process Report for the project.

**8.2.2** The Commissioning Authority should aid in the coordination of the callback of contractors during the Occupancy and Operations Phase. Since the Commissioning Authority has been involved since the Pre-Design Phase, he/she has the ability to identify which contractors should be contacted to resolve an issue.

**8.2.3** Verification of the performance of all systems and assemblies being commissioned should be completed during the Construction Phase. However, certain weather conditions, load conditions, or occupant interactions are required to complete some verification activities. Such deferred performance verification shall be conducted at an appropriate time, and under appropriate conditions, as early as possible after occupancy.

**8.2.4** Training of the Owner's operation and maintenance personnel on the fundamentals of facility and system/assembly operations and the occupants on facility usage will ideally occur primarily during the Construction Phase of a project. Some training, however, is likely to be best deferred until the Owner has assumed responsibility for his/her facility. Such training will be defined in the Commissioning Plan and Contract Documents.

**8.2.4.1** Ongoing training is an integral part of a Continuous Commissioning Process. The Owner's operation and maintenance personnel and the occupants will be critical members of the Commissioning Team responsible for these periodic efforts.

**8.2.5** The final project Commissioning Process Report will be completed during this phase. The requirements for a successful Commissioning Process Report are described in Section 7. Content not available or incomplete at the end of the Construction Phase will be added during this phase.

**8.2.5.1** Should the Owner choose to implement the Continuous Commissioning Process for his/her facility, periodic Commissioning Process Reports will be created throughout the Occupancy and Operations Phase to reflect the Commissioning Process activities undertaken.

**8.2.6** The final project Systems Manual will be completed during this phase. The requirements for a successful Systems Manual are described in Section 7. Content not available or incomplete at the end of the Construction Phase will be added during this phase.

**8.2.6.1** The Systems Manual needs to be updated as changes are made to the facility throughout the entire Occupancy and Operations Phase. This includes updating the Owner's Project Requirements to reflect current conditions and needs and updating the Basis of Design to reflect changes to systems and assemblies.

**8.2.7** Dynamic systems and equipment, as well as static systems, assemblies, and components, will tend to migrate from their as-installed conditions over time. In addition, the needs and demands of facility users and processes typically change as a facility is used. To attain optimal performance of facility systems, periodic verification of system, assembly, and component condition and operation is essential. The Systems Manual provides the tools and documented benchmarks for evaluation of ongoing performance. Such periodic verification is often best done in the context of a Continuous Commissioning Process.

**8.2.8** The Continuous Commissioning Process has the following key activities:

- (a) Maintaining the Owner's Project Requirements to reflect changes in use and operation of the facility.
- (b) Maintaining the Basis of Design to reflect changes in systems and assemblies due to renovations or in response to changes in the Owner's Project Requirements.
- (c) Periodic evaluation of achieving the current Owner's Project Requirements and against previous benchmarks by appropriate tests.
- (d) Maintaining the Systems Manual to reflect changes in Owner's Project Requirements, Basis of Design, and systems/assemblies.
- (e) Ongoing training of operations and maintenance personnel and occupants on current Owner's Project Requirements and Basis of Design and changes in systems and assemblies.

### **8.3 Occupancy and Operations Phase Acceptance Requirements**

**8.3.1** The Commissioning Process should include the formal acceptance by the Commissioning Authority and the Owner of any deferred training, the final project Systems Manual, and the Final Commissioning Process Report during the Occupancy and Operations Phase.

### **8.4 Occupancy and Operations Phase Documentation Requirements**

**8.4.1** The final project Commissioning Process Report and final project Systems Manual are the primary documen-

tation requirements for the Occupancy and Operations Phase Commissioning Process. The information in these deliverables is used throughout the life of the facility.

**8.4.2** If periodic performance verification is conducted for the Owner, a Continuous Commissioning Process Report and updates (as necessary) to training and the Systems Manual should be provided as deliverables.

## **8.5 Occupancy and Operations Phase Training Requirements**

**8.5.1** The Commissioning Process training requirements for the Occupancy and Operations Phase are discussed in Section 8.2.4.

## **9. REFERENCES**

1. DeVor, R., T. Chang, and J. Sutherland. 1992. *Statistical Quality Control: Contemporary Concepts and Methods*, Macmillan Publishing Company, New York, Chapter 7.
2. Gitlow, H. and S. Gitlow. 1987. *The Deming Guide to Quality and Competitive Position*, Prentice-Hall, Englewood Cliffs, NJ, Chapter 3.
3. Juran, J.M. (Ed.). 1995. *A History of Managing for Quality: The Evolution, Trends, and Future Directions of Managing for Quality*, ASQC Quality Press, Milwaukee, WI.

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**(This is a normative annex and is part of this guideline.)**

### **NORMATIVE ANNEX A GUIDE FOR DEVELOPING SUPPLEMENTARY TECHNICAL GUIDELINES FOR THE COMMISSIONING PROCESS**

The purpose of this annex is to provide the recommended format and content for Total Building Commissioning Process supporting technical guidelines. The objective is to use the same format for all Commissioning Process guidelines. The National Institute of Building Sciences is facilitating the development of a number of technical topic guidelines to support the effective implementation of the Total Building Commissioning Process. These guidelines will be developed by various professional, technical, and trade organizations. For example, the technical guideline for heating, ventilating, air-conditioning, and refrigeration (HVAC&R) will be developed by ASHRAE. The technical guidelines are developed to assist the Commissioning Team in successfully using the Commissioning Process for various systems and assemblies. The goal is to use the process as defined and provided in Guideline 0, "The Commissioning Process." Further, it is desired that each different system or assembly involved in the construction, addition to, or rehab of buildings, structures, campuses, or utilities use the Commissioning Process from Guideline 0-2005 and not redefine it within the respective (topic) technical guideline.

The objective of both Guideline 0-2005 and the technical guidelines is to provide information on implementing the Commissioning Process. The technical guidelines are not intended to be a detailed user's guide or provide guide speci-

fications, full commissioning plans, development of owner's project requirements, construction checklists, statistical or other quality tools, or other detailed requirements for implementing the Commissioning Process.

The format of the technical guidelines should follow the same format used in Guideline 0-2005. The following is the general organization to be used in the development of the technical guidelines.

## **FOREWORD**

The Foreword should provide key information on what has led to success on previous projects, the role of the specific technology in a successful building or construction project, and closely related supplementary technical guidelines or topics.

## **SECTION 1, PURPOSE**

The following should be used as the general purpose for each technical guideline:

"The purpose of this guideline is to describe the technical requirements for the application of the Commissioning Process described in ASHRAE Guideline 0-2005 that will verify that the [*insert topic, for example, fire systems or envelope assembly*] achieves the Owner's Project Requirements."

## **SECTION 2, SCOPE**

The following text should be used as the general scope for each technical guideline:

"The procedures, methods, and documentation requirements in this guideline describe the application of the Commissioning Process for each project delivery phase from Pre-design through Owner Occupancy and Operation for [*insert topic*] to support the Commissioning Process activities described in ASHRAE *Guideline 0-2005, The Commissioning Process* (also published by NIBS as Guideline 0, *The Total Building Commissioning Process*). This includes requirements for:

- (a) [*insert topic*] to fully support the Total Building Commissioning Process activities,
- (b) verification during each phase of the Commissioning Process,
- (c) acceptance at each phase,
- (d) documentation during each phase,
- (e) Systems Manual, and
- (f) training for operations and maintenance personnel and occupants."

## **SECTION 3, UTILIZATION**

The following paragraphs should be included as the Utilization section:

**3.1** The application of this guideline will depend upon the Owner's Project Requirements and how the project will be designed, built, and operated. This guideline is supplemental to the Commissioning Process detailed in ASHRAE Guideline 0-2005.

**3.2** This guideline describes specific details required to properly implement the Commissioning Process relative to

[insert topic]. This includes documentation, test procedures, and checklists.

#### SECTION 4, DEFINITIONS

Include definitions that are unique to the technical guideline. Do not redefine or repeat those in ASHRAE Guideline 0; instead, include a statement referring to the definitions in Section 4 of Guideline 0.

#### SECTION 5, PRE-DESIGN PHASE

The following needs to be included in the Pre-Design Phase section for [insert topic]:

1. List of Commissioning Team members.
2. List and description of criteria and items to be included in the Owner's Project Requirements document.
3. List of milestones.
4. List of specialists required for implementing the Commissioning Process.
5. List of items to focus upon during the design reviews.
6. List of items to be included in the Commissioning Plan.
7. List of items to be included as part of the Issues Log.
8. List of items required for acceptance of Pre-Design Phase commissioning.
9. Develop needs for tests and list tests that need to be performed.
10. Develop training requirements.
11. Develop requirements for the Systems Manual, such as parts lists, troubleshooting needs, operations and maintenance requirements, system description, level at which each set of material needs to be written for clear understanding.

#### SECTION 6, DESIGN PHASE

The following needs to be included in the Design Phase section for (topic). This will be the basis for Construction Phase documents for contractors, vendors, and equipment/assembly manufacturers:

1. List of items required for the Basis of Design.
2. Revision review procedure for Commissioning Team members and Owner's Project Requirements.
3. List of coordination requirements and items provided by others.
4. Key milestones that need to be reviewed.
5. Update lists of specialists required to implement the Commissioning Process based upon the actual design and interrelationship with other systems and assemblies.
6. List of items to be included in the construction documents.
7. Develop lists of priority items and relate whenever possible to safety, health, energy, environmental impact, aesthetics, operations and maintenance, in addition to Owner's Project Requirements.
8. List of Construction Checklists to be used by the contractor.

9. Samples of Construction Checklists. Examples of construction checklists are included in Annex M to this guideline and in other annexes in other supplementary technical guidelines (such as ASHRAE Guideline 1-200x, HVAC&R Technical Requirements for the Commissioning Process).
10. List of items to be included in the Systems Manual, such as parts lists, troubleshooting needs, operations and maintenance requirements, system description, level at which each set of material needs to be written for clear understanding.
11. List of training requirements, timing, learning outcomes.
12. Develop needs for tests and tests that need to be performed.
13. List of items required for acceptance of Design Phase commissioning.

#### SECTION 7, CONSTRUCTION PHASE

The following needs to be included in the Construction Phase section for [insert topic]:

1. List of test procedures and data forms to verify achievement of Owner's Project Requirements and Basis of Design.
2. Samples of test procedures and data forms. Examples of these are included in Annex U to other supplementary technical guidelines (such as ASHRAE Guideline 1-200X, HVAC&R Technical Requirements for the Commissioning Process).
3. List of coordination requirements and items provided by others.
4. List of specific items for the site visit procedures.
5. Tests needs and schedule.
6. Commissioning Team meetings.
7. Issues Logs.
8. Input into the final Commissioning Process Report.
9. Lessons-learned workshop schedule during Occupancy and Operations Phase.
10. List of items required for acceptance of Construction Phase commissioning.

#### SECTION 8, OCCUPANCY AND OPERATIONS PHASE

The following needs to be included in the Occupancy and Operations Phase section for [insert topic]:

1. List of training items to be accomplished during the first year of operation.
2. List of warranty items to be checked during the first year of operation.
3. List test requirements during occupancy, including periodic re-testing for a successful continuous operation of the facility.
4. List who should attend the lessons-learned workshop.
5. List of criteria to be included in the final Commissioning Process Report.
6. List of items required for acceptance of Occupancy and Operations Phase commissioning.

## SECTION 9, REFERENCES

Include industry-specific references that support recommendations for benchmarking, testing, and other supporting guidance in the development of the Owner's Project Requirements, Basis of Design, tests, and other Commissioning Process documents.

## ANNEXES

Annexes are to be used to provide additional information, examples of documentation, examples of specifications, acceptance procedure details, and other items that are not required to achieve compliance with the technical guideline but will assist in implementing the Commissioning Process for the specific technical system or assembly. This is the place to illustrate best practices and to provide information on how to achieve best practice and economy in design. Annex Q, References, should provide current articles, guides, and other information on implementing the Commissioning Process for the specific supporting technical requirements guidelines.

The desired goal is to have all Commissioning Process guidelines use the same annex designation. They should use the same annex letters as Guideline 0-2005. If an annex is not required, it should specifically be so noted in each technical guideline—suggested wording: “This annex is intentionally left blank” or “There is no supplemental information required for [insert assembly or system] technology.” Annex A will be empty in all supplemental guidelines. Annex B is specific to Guideline 0 and should not be changed in supplemental guidelines. Annexes C through E may require no modification for most supplemental guidelines.

**NOTE:** The list and numbering of annexes, to be in compliance with Guideline 0-2005, must be as follows:

- Annex A – Guide for Developing Supplementary Technical Guidelines for the Commissioning Process (used only in Guideline 0)
- Annex B – Commissioning Process Flowchart (used only in Guideline 0)
- Annex C – Cost and Benefits of the Commissioning Process (typically only in Guideline 0)
- Annex D – Commissioning Process Documentation Matrix (typically only in Guideline 0)
- Annex E – Commissioning Process Request for Qualifications (typically only in Guideline 0)
- Annex F – Roles and Responsibilities
- Annex G – Commissioning Plan
- Annex H – Acceptance Plan
- Annex I – Owner's Project Requirements Workshop Guidance
- Annex J – Owner's Project Requirements
- Annex K – Basis of Design
- Annex L – Specifications
- Annex M – Construction Checklists
- Annex N – Quality-Based Sampling Examples
- Annex O – Systems Manual
- Annex P – Training Manual and Training Needs
- Annexes Q through X – In addition to the annexes (above) that are included in Guideline 0-2005, *The*

*Commissioning Process*, all supplemental technical guidelines should include the following annexes with specific technical topic guidance or requirements, as appropriate. It is the intent to have all technical guidelines use the same reference letter for each topic. That is, all examples of Checklists would always be included in Annex M. The technical Commissioning Process guidelines should include annexes that provide examples and guidance on the following topics or should include notes such as “Not used,” or “This annex is intentionally left blank,” or “There is no supplemental information required.”

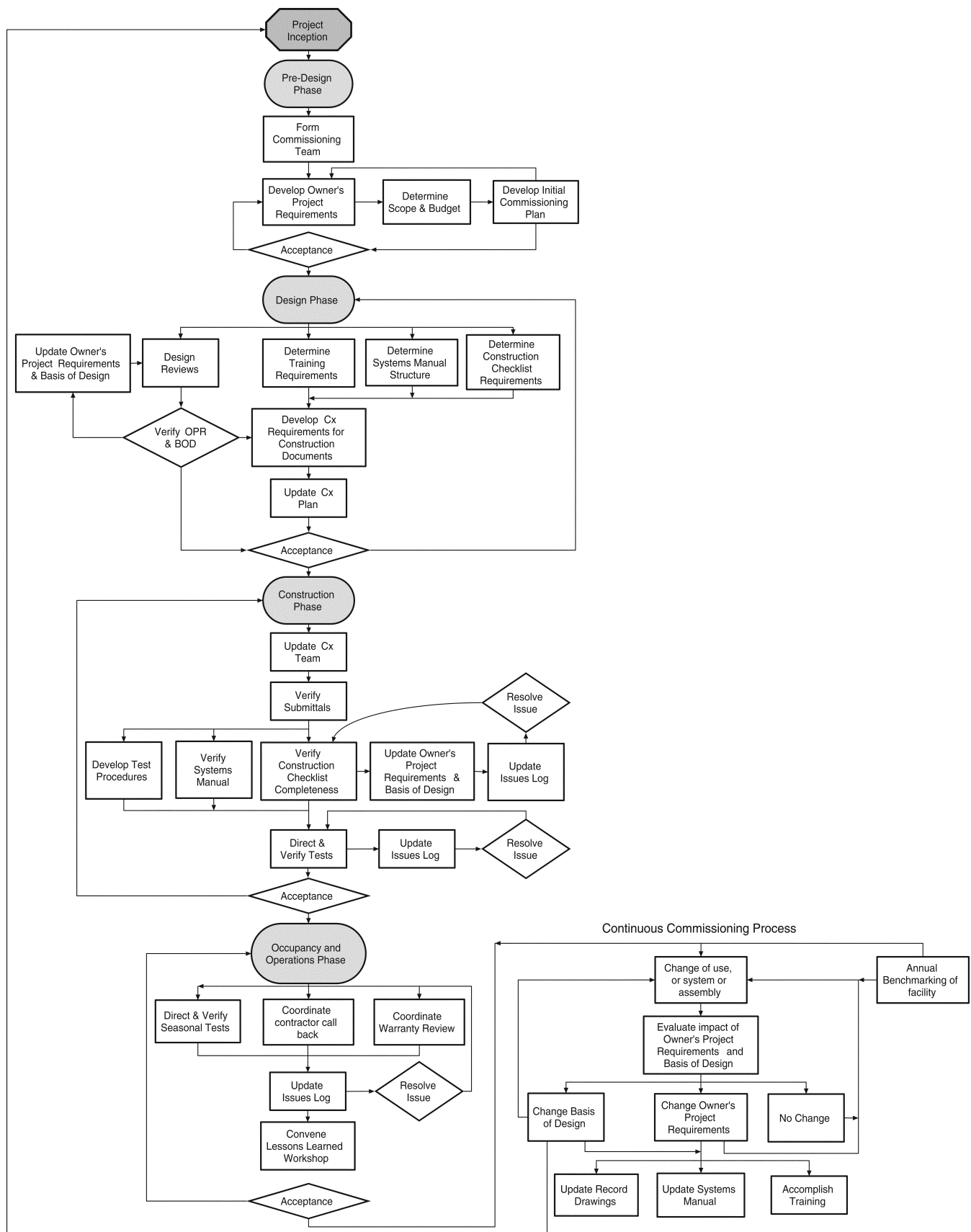
- Annex Q – Publications, Articles, References, Codes, Regulations, and Standards
- Annex R – Integration Requirements
- Annex S – Interference and Coordination with Other Systems and Assemblies
- Annex T – Communications: What, When, and Who
- Annex U – Test Procedures and Data Forms
- Annex V – Pre-Design Phase Commissioning Process Specific Needs
- Annex W – Design Phase Commissioning Process Specific Needs
- Annex X – Construction Phase Commissioning Process Specific Needs
- Annex Y – Occupancy and Operations Phase Commissioning Process Specific Needs
- Annex Z (and, if needed, Annex AA and beyond) can be used as required for other topics that are determined to be useful for a specific assembly or system.

**(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)**

## INFORMATIVE ANNEX B COMMISSIONING PROCESS FLOW CHART

*This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.*

The flow chart shown in Figure B.1 depicts an example for an owner who has adopted the Commissioning Process from project inception. If the owner adopts the Commissioning Process after project inception, then the tasks shown are still accomplished in whatever phase the Commissioning Process commences. The Continuous Commissioning Process is shown in the flow chart as ongoing tasks during the Occupancy and Operations Phase after the last acceptance block.



**Figure B.1 Commissioning process flow chart.**

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

## **INFORMATIVE ANNEX C**

### **COST AND BENEFITS OF THE COMMISSIONING PROCESS**

*This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.*

#### **OVERVIEW**

The Commissioning Process focuses on producing a quality-based system that achieves the Owner's Project Requirements.

This annex discusses the potential benefits and where they accrue and quantifies these benefits by providing evidence of potential costs and savings.

#### **DISCUSSION OF NEW COST ITEMS**

Ultimately, the owner of the facility will determine the extent of the Commissioning Process activities and who will be responsible for each phase of work. The intent here is to outline the scope of work that represents new cost items rather than to assign responsibilities for each task. The cost of the Commissioning Process should be considered as a part of the project budget.

#### **Design Professional**

In addition to the design professional's typical scope of work, including the preparation of design drawings and specifications, the Commissioning Process often requires that the design professional work with the Commissioning Authority to integrate the Commissioning Process activities into the project specifications. These activities typically include:

1. Test requirements and documentation.
2. Operational, maintenance, and troubleshooting documentation requirements.
3. Construction Checklists.
4. Systems Manual.
5. Comprehensive training program for operation and maintenance personnel and users.

The design professional may also be responsible for reviewing the Commissioning Plan at the various phases of the process and for delivering the Basis of Design in a format specific for the owner.

#### **Commissioning Authority**

The activities accomplished by the Commissioning Authority as defined in this guideline require that additional funds be allocated during the Pre-Design, Design, and Construction Phases. These funds are allocated from the savings obtained through fewer change orders and requests for information and through reduced problems during start-up of the systems and occupancy of the facility.

#### **Contractors**

The completion of some detailed tests is unique to the Commissioning Process. The contractor will have additional work and costs associated with completing these tests.

#### **DISCUSSION OF BENEFITS**

For convenience and clarity, benefits will be discussed as they relate to major participants in the Commissioning Process: the Design Professional, the Contractor, and the Owner.

#### **Benefits to the Design Professional**

Potential benefits include:

- Facility will achieve the of Owner's Project Requirements.
- Reduced risk exposure.
- Improved knowledge base for use in future designs and installation.
- Benefit of other participants' input, leading to the most cost-effective design and operation.
- Reduced number of interference drawings during construction due to improved communication and coordination throughout the project.

#### **Benefits to the Contractor**

Potential benefits include:

- Improved planning and coordination through the implementation of the Commissioning Plan.
- Improved coordination between different trades and reduced likelihood of site interference drawings required of contractors throughout the project. Reduced number of deficiencies at substantial completion. Reduced number of callbacks.
- Reduced number of calls for operational guidance due to participation in training programs for operations and maintenance personnel.

#### **Benefits to the Owner**

Potential benefits include:

- Improved operator knowledge of how to optimize the facility operation and maintenance due to the early inclusion of operators in the Commissioning Process.
- Reduced training requirements due to continuously updated documentation of how systems should operate and be maintained; personnel will only need to be trained with regard to changes.
- Facility performance is in accordance with the Owner's Project Requirements.
- Systems Manual provides an easy reference document for system and assembly operation and maintenance.
- Reduced downtime due to better diagnosis of failures.
- Improved ability to provide accurate information to occupants on facility operation and maintenance.
- Lower operating costs due to improved operational techniques.
- Benefits to building occupants, including greater worker productivity, reduced complaints, and reduced incidence of absenteeism.

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

## INFORMATIVE ANNEX D COMMISSIONING PROCESS DOCUMENTATION MATRIX

*This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive repre-*

*sentation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.*

The following table summarizes the documents that are produced during the implementation of the Commissioning Process on a project.

**TABLE D-1 Documentation Matrix**

Phase	Document	Input By	Provided By	Reviewed/ Approved By	Used By	Notes
Pre-Design	Owner's Project Requirements	O&M, Users, Capital Projects, Design Team (?)	CA or Designer	Owner	CA, Design Team	Design Team may not be hired yet.
	Commissioning Plan	Owner, Design Team (?), CA	CA	Owner	CA, Owner, Design Team	Design Team may not be hired yet.
	Systems Manual Outline	O&M, CA	Owner or CA	Owner	Design Team	May be included in OPR
	Training Requirements Outline	O&M, Users, CA, Design Team	Owner or CA	Owner	Design Team	May be included in OPR
	Issues Log	CA	CA	N/A	CA, Design Team	May be only format at this phase
	Issues Report	CA	CA	Owner	Design Team, Owner	
	Pre-Design Phase Commissioning Process Report	CA	CA	Owner	Owner	Close of Phase report
Design	Owner's Project Requirements Update	O&M, Users, Capital Projects, Design Team	CA or Designer	Owner	CA, Design Team	
	Basis Of Design	Design Team	Design Team	Owner, CA	Design Team, CA	
	Construction Specifications for Commissioning	Design Team, CA, Owner	Design Team or CA	Owner	Contractors, CA, Design Team	May also be provided by Project Manager/ Owner's Rep.
	Systems Manual Outline-Expanded	Design Team, CA, O&M, Contractor (?)	Design Team or CA	Owner, CA	Design Team, Contractor	Contractor may not be hired yet.
	Training Requirements In Specifications	O&M, Users, CA, Design Team	Owner or CA	Owner	Design Team	Contractor may not be hired yet
	Design Review Comments	CA	CA	Owner	Design Team	
	Issues Log	CA	CA	N/A	CA, Design Team	
	Issues Report	CA	CA	Owner	Design Team, Owner	
	Design Phase Commissioning Process Report	CA	CA	Owner	Owner	Close of Phase report
Construction	Owner's Project Requirements Update	O&M, Users, Capital Projects, Design Team	CA or Designer	Owner	CA, Design Team, Contractors	
	Basis of Design Update	Design Team	Design Team	CA, Owner	Design Team, CA	
	Commissioning Plan Update	Design Team, CA, Owner, Contractor	CA	CA, Owner, Design Team, Contractor	CA, Owner, Design Team, Contractors	
	Submittal Review Comments	CA	Design Team	Design Team	Contractor	

**Notes:**

1. The term "contractor" is understood to refer to any of several entities that provide construction services. Depending upon the project, this could include, among others, the owner's representative, construction manager, contractors, and subcontractors.
2. Abbreviations: CA: Commissioning Authority; O&M: operations and maintenance personnel; OPR: Owner's Project Requirements.

**TABLE D-1 (Continued) Documentation Matrix**

Phase	Document	Input By	Provided By	Reviewed/ Approved By	Used By	Notes
	System Coordination Plans	Contractor, Design Team	Contractor	CA, Design Team	Contractor, CA	
	Inspection Checklists	CA, Contractor, Design Team	CA	CA, Design Team	Contractor	
	Inspection Reports	Contractor	CA	CA, Owner	Contractor	
	Test Procedures	CA, Contractor, Design Team	CA	CA, Design Team	Contractor	
	Test Data Reports	Contractor	CA	CA, Owner	Contractor	
	Commissioning Meeting Agendas and Minutes	CA	CA	All	All	
	Training Plans	Design Team, CA, O&M, Contractor	Contractor or CA	Owner, CA	O&M, Users, Contractor	
	Systems Manual	Design Team, CA, O&M, Contractor	Contractor	Owner, CA	O&M, Users	
	Issues Log	CA	CA	N/A	CA, Design Team, Contractor	
	Issues Report	CA	CA	Owner, Design Team	Design Team, Owner, Contractor	
	Preliminary Construction Commissioning Process Report	CA	CA	Owner	Owner	Prior to Occupancy
	Final Construction Phase Commissioning Process Report	CA	CA	Owner	Owner	Close of Phase report
Occupancy and Operations	Owner's Project Requirements Update	O&M, Users, Design Team	CA or Designer	Owner	CA, Design Team, Contractors	
	Basis of Design Update	Design Team	Design Team	CA, Owner	Design Team, CA	
	Maintenance Program	O&M, Contractor, CA	Owner or CA	Owner, CA	O&M, Users	
	Test Procedures	Contractor, CA, O&M, Design Team	CA	Design Team, CA	Contractor	
	Test Data Reports	Contractor	CA	CA, Owner	Contractor, O&M	
	Issues Log	CA	CA	N/A	CA, Design Team, Owner, Contractors	
	Issues Report	CA	CA	Owner	Design Team, Owner, Contractors	
	Commissioning Process Report	CA	CA	Owner	Owner	Final report
	Re-Commissioning Plan	O&M, Users, CA	CA or Owner	Owner	Owner	

**Notes:**

1. The term "contractor" is understood to refer to any of several entities that provide construction services. Depending upon the project, this could include, among others, the owner's representative, construction manager, contractors, and subcontractors.
2. Abbreviations: CA: Commissioning Authority; O&M: operations and maintenance personnel; OPR: Owner's Project Requirements.

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

## INFORMATIVE ANNEX E COMMISSIONING PROCESS REQUEST FOR QUALIFICATIONS

*This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.*

### BACKGROUND

\_\_\_\_\_ (Owner) is seeking the services of a qualified Commissioning Authority for \_\_\_\_\_. The project is a \_\_\_\_\_ gross ft<sup>2</sup>, \_\_\_\_\_ story, Class \_\_\_\_\_ [type] \_\_\_\_\_ building in [city & state] \_\_\_\_\_, \_\_\_\_\_, with a project budget of \$\_\_\_\_\_ million. The facility is expected to be composed of \_\_\_\_\_% [space type], \_\_\_\_\_% [space type], and \_\_\_\_\_% [space type].

The project is currently in the early pre-design phase. The expected schedule is to start design by \_\_\_\_\_, start construction by \_\_\_\_\_, and occupy by \_\_\_\_\_.

The management structure is traditional design/bid/build with full design documents and specifications being developed by an architectural/engineering firm. The construction documents will be let out to bid and a general contractor will be hired to complete the construction. The Owner's primary construction representative on site will be provided by the separately contracted services of a construction manager. The Commissioning Authority will be hired by and report directly to the Owner.

### SCOPE OF WORK

The Owner has adopted the Commissioning Process as his/her quality process to plan, design, construct, and operate this facility. As with any quality process, the Commissioning Process provides tools to enable everyone involved in the construction of the facility to verify that the final facility meets the Owner's Project Requirements.

The following is a summary of the Commissioning Process that the Owner intends to implement on this project. The proposer is free to suggest changes and improvements to this process. However, for this proposal the following process will be assumed.

#### Commissioning Process During the Pre-Design Phase

The Commissioning Process activities completed by the Commissioning Authority during the Pre-Design Phase include:

- Developing and documenting the Owner's Project Requirements.
- Identifying a scope and budget for the Commissioning Process.

- Developing the initial Commissioning Plan.
- Acceptance of Pre-Design Phase Commissioning Process activities.

#### Commissioning Process During the Design Phase

The Commissioning Process activities completed by the Commissioning Authority during the Design Phase include:

- Works with the Commissioning Team to document the Owner's Project Requirements for the facility.
- Works with the design professionals in documenting the Basis of Design.
- Verifies the Basis of Design with regard to the Owner's Project Requirements.
- Develops a Commissioning Plan encompassing the Design, Construction, Occupancy and Operations Phases.
- Determines the commissioning requirements and activities to include in the Construction Documents, with review by the design team, for integration into the project's construction specifications.
- Reviews the in-depth design documentation developed by the design professionals.
- Performs statistically based quality design review at 35%, 50%, 95%, and 100% completion of the drawings and specifications.

#### Commissioning Process During the Construction Phase

The Commissioning Process activities accomplished by the Commissioning Authority during the Construction Phase include:

- Organizes the Commissioning Process components and conducts a pre-bid and pre-construction meeting where the Commissioning Process requirements are reviewed with the Commissioning Team.
- Organizes and conducts periodic Commissioning Team meetings necessary to plan, develop the scope of, coordinate, and schedule activities and resolve problems.
- Reviews submittals concurrent with the design professional's review.
- Works with Contractors in completing Construction Checklists and tracking of Checklist completion.
- Statistically samples completion of Construction Checklists on a periodic basis to verify that Contractor's quality process is achieving the Owner's Project Requirements.
- Develops specific test procedures. The Contractors review the procedures.
- Directs the execution of the tests by the Contractors.
- Documents the results of the tests.
- Documents the correction and retesting of noncompliance items by the Contractor.
- Reviews the Systems Manual for achieving the Owner's Project Requirements.
- Reviews, pre-approves, and verifies the training provided by the Contractors.
- Verifies delivery of the Systems Manual.

## Commissioning Process During the Occupancy and Operations Phase

The Commissioning Process activities accomplished by the Commissioning Authority during the Occupancy and Operations Phase include:

- Schedules and verifies deferred and seasonal testing by the Contractor.
- Verifies continuing training.
- Accomplishes a review of warranties with the operations and maintenance staff two months prior to expiration of warranty.
- Schedules, organizes, and attends a lessons-learned workshop. The workshop is facilitated by an independent member of the Commissioning Authority's firm.
- Completes the Final Commissioning Process Report.

## LIMIT OF RESPONSIBILITIES

The Commissioning Authority is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The Commissioning Authority may assist with problem-solving or resolving nonconformance or deficiencies, but ultimately that responsibility resides with the general contractor and design professionals.

## FOCUS OF THE COMMISSIONING PROCESS

The following systems and assemblies are the focus of the Commissioning Process:

- *[Insert list of systems and assemblies]*

## DESIRED QUALIFICATIONS

It is desired that the person designated as the Commissioning Authority satisfy as many of the following requirements as possible:

1. Has acted as the principal Commissioning Authority for at least three projects during the past year. [Note that the size of the project should be accounted for. Whereas one proposer may have done ten projects all small in size, another proposer that accomplished one large and complex project may have equal credentials].
2. Experienced in quality processes.
3. Knowledgeable in building operation and maintenance training.
4. Excellent verbal and written communication skills. Highly organized and able to work with both management and trade contractors.
5. A bachelor's degree in *[insert discipline]* is strongly preferred and *[insert type]* certification or professional license is desired.
6. The Commissioning Authority's firm will demonstrate depth of experienced personnel and capability to sustain loss of assigned personnel without compromising quality and timeliness of performance.

7. The Commissioning Authority will be an independent contractor and not an employee or subcontractor of the General Contractor or any other subcontractor on this project, including the design professionals.
8. *[Insert any qualifications or special requirements for a specific system or assembly].*

## INSTRUCTIONS TO PROPOSERS

A proposer must propose to execute all phases of the Commissioning Process in a single proposal. The proposal must be signed by an officer of your firm with the authority to commit the firm.

1. List the key individual who will be the Commissioning Authority for this contract and describe his or her relevant qualifications and experience. This information is required in addition to any detailed resumes the proposer submits. The contract will require that this individual be committed to the project for its duration.
2. Provide project and professional references and experience for three to five commissioning projects for which the proposer was the principal Commissioning Authority in the last three years. Include a description of the projects, identify when the proposer came into the projects, and describe the involvement of each individual on the proposer's team in the projects. For each project, attach a sheet that includes the name and telephone number of the Owner's project manager, construction manager, facility administrator of the building, the design professionals, and the contractors.
3. Describe any experience of the proposer's team in the following areas. List each party's involvement.
  - (a) Quality process experience.
  - (b) Operation and maintenance experience.
  - (c) Design experience.
  - (d) Life-cycle costing.
  - (e) *[Insert other system or assembly specific experience requirements].*
4. Describe your proposed approach to managing the project expertly and efficiently, including your team participation. Describe what approach you will take to integrate the Commissioning Process into the normal design and construction process in order to make it "business as usual."
5. Describe what you will do to foster teamwork and cooperation from contractors and designers and what you will do to minimize adversarial relationships.
6. Describe how your work will facilitate the use of your product as a prototype that may be subsequently used by the Owner in future projects, including access to the electronic versions of all documents and forms.
7. As an attachment, provide the following work products that members of the proposer's team wrote.
  - (a) Commissioning Plan that was executed.
  - (b) Integrated commissioning specifications.
  - (c) Electronic Issues Log.
  - (d) Construction Checklists.
  - (e) Test procedure that was executed.
8. *[Insert any other desired instructions].*

## SELECTION CRITERIA

The submitted proposals will be reviewed and ranked according to the following (items from the above numbered list):

- |   |                  |
|---|------------------|
| 1. Key individual experience              | 20 points        |
| 2. Staff experience                       | 15 points        |
| 3. Similar project experience             | 20 points        |
| 4. Team experience in related skill areas | 15 points        |
| 5. Management approach                    | 20 points        |
| 6. Work examples                          | <u>10 points</u> |
|   | 100 points       |

Reference checks will not be scored individually but may be used to supplement all categories. The Owner reserves the right to eliminate or change the weight of extremely high or extremely low fee proposals.

## SUBMISSION AND SELECTION

Consultants will submit [quantity \_\_\_\_\_] copies of the written proposal, to be received in the Owner's office at [address \_\_\_\_\_] by [date and time \_\_\_\_\_]. Late proposals will not be accepted.

Review and selection process.....

Requirement of personal interview for finalists.....

## LIMITATIONS AND PROVISIONS

*[Insert wording on right to reject, to seek clarifications, to negotiate a final contract; cost of proposal preparation not reimbursable; primary contact for questions; other necessary legal language, etc.]*

## MINIMUM REQUIREMENTS FOR CONTRACT EXECUTION

### General Conditions

Miscellaneous as required.....

### Insurance

The Commissioning Authority's firm shall obtain, at the firm's expense, and keep in effect during the term of the project, \$[list required insurance].

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## INFORMATIVE ANNEX F ROLES AND RESPONSIBILITIES

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Understanding and defining the role of each participant is vital to the success of the Commissioning Process. This annex provides an example of the responsibilities of each participant in a comprehensive Commissioning Process. These responsibilities shall be documented in the contracts between the owner and the contractor(s) and the owner and the design professionals. The responsibilities of each participant should be included in the contract documents.

The responsibilities of the owner, Commissioning Authority, design professionals, construction manager, contractors, and manufacturers are detailed below.

### OWNER

1. Include a statement regarding design professional commissioning responsibilities and scope in the request for design services.
2. Develop and commit to the Owner's Project Requirements for the facility and its use.
3. Assign operations and maintenance personnel and schedule them to participate in the various meetings, training sessions, and observations/inspections as follows:
  - (a) Design Phase coordination meetings.
  - (b) Construction Phase coordination meetings.
  - (c) Initial owner-training session at initial placement of major equipment.
  - (d) Maintenance orientation and inspection.
  - (e) System testing verification meetings.
  - (f) Procedures meeting for testing systems.
  - (g) Owner's training session.
  - (h) Verification demonstrations.
  - (i) Systems and assemblies tests.
  - (j) Final review at acceptance meeting.
4. Review and approve any changes made to Owner's Project Requirements.
5. Review and approve the Construction Documents.
6. Provide qualified personnel for videotaping and editing of training sessions.
7. Videotape construction progress.
8. Review and comment on the Commissioning Authority's Commissioning Process Progress Reports.
9. Review and comment on the Commissioning Authority's verification reports.
10. Review and accept the Commissioning Authority's Commissioning Process Report.

### COMMISSIONING AUTHORITY

1. Organize and lead the Commissioning Team.
2. Facilitate and document the Owner's Project Requirements.
3. Verify that the Commissioning Process activities are clearly stated in all scopes of work.
4. Integrate the Commissioning Process activities into the project schedule.

5. Prepare a Commissioning Plan that describes the extent of the Commissioning Process to accomplish the Owner's Project Requirements. Update the Commissioning Plan during each phase of the project to incorporate changes and additional information.
6. Review and comment on the ability of the design documents to achieve the Owner's Project Requirements for the commissioned systems and assemblies.
7. Prepare the Commissioning Process activities to be included as part of the project specification. Include a list of all individual trade contractor responsibilities for all the Commissioning Process activities (list contractors by name, firm, and trade specialty if known).
8. Execute the Commissioning Process through the writing and review of Commissioning Process Reports, organization of all Commissioning Team meetings, tests, demonstrations, and training events described in the Contract Documents and approved Commissioning Plan. Organizational responsibilities include preparation of agendas, attendance lists, arrangements for facilities, and timely notification to participants for each Commissioning Process activity. The Commissioning Authority shall act as chair at all commissioning events and ensure execution of all agenda items. The Commissioning Authority shall prepare minutes of every Commissioning Process activity and send copies to all Commissioning Team members and attendees within five workdays of the event.
9. Review the plans and specifications (during the Pre-Design and Design Phases) with respect to their completeness in all areas relating to the Commissioning Process. This includes verifying that the Owner's Project Requirements have been achieved, and that there are adequate devices included in the design to properly test the systems and assemblies and to document the performance of each piece of equipment, system, or assembly.
10. Schedule all document review coordination meetings.
11. Attend the project's pre-bid meeting to detail the design professional or contractor Commissioning Process requirements.
12. Schedule the pre-design and pre-construction Commissioning Process meeting within 60 days of the award of the contract at some convenient location and at a time suitable to the attendees. This meeting will be for the purpose of reviewing the complete Commissioning Process and establishing tentative schedules for the Design Phase and Construction Phase commissioning activities.
13. Develop the initial format to be used for Issues Logs throughout and for each phase of the Commissioning Process.
14. Schedule the initial owner training session so that it will be held immediately before the contractor training. This session will be attended by the owner's O&M personnel, the design professionals, the contractor, and the Commissioning Authority. The Commissioning Authority will review the Owner's Project Requirements and the design professional(s) will review the Basis of Design.
15. Review proposed contractor-provided training program to verify that the Owner's Project Requirements are achieved.
16. Attend a portion of the contractor-provided training sessions to verify that the Owner's Project Requirements are achieved.
17. Receive and review the Systems Manual as submitted by the contractor. Verify that it achieves the Owner's Project Requirements. Insert systems descriptions as provided by the design professional(s) in the Systems Manual.
18. Witness system and assembly testing. Verify the results and include a summary of deficiencies.
19. Supervise the Commissioning Team members in completion of tests. The test data will be part of the Commissioning Process Report.
20. Periodically review Record Drawings for accuracy with respect to the installed systems. Request revisions to achieve accuracy.
21. Verify that the Systems Manual and all other design and construction records have been updated to include all modifications made during the Construction Phase.
22. Repeat implementing of tests to accommodate seasonal tests or to correct any performance deficiencies. Revise and resubmit the Commissioning Process Report.
23. Prepare the final Commissioning Process Report.
24. Assemble the final documentation, which includes the Commissioning Process Report, the Systems Manual, and all record documents. Submit this documentation to the owner for review and acceptance.
25. Recommend acceptance of the individual systems and assemblies to the owner (in accord with the defined project requirements).

#### **DESIGN PROFESSIONAL**

1. Participate and assist in the documentation of the initial Owner's Project Requirements.
2. Document revisions to the Owner's Project Requirements and obtain approval from the owner.
3. Document the Basis of Design
4. Prepare Contract Documents, including the integration of the Commissioning Process requirements and activities provided by the Commissioning Authority.
5. Prepare Contract Documents that coordinate required interfaces between systems and assemblies.
6. Attend the Pre-Design and Design Phase coordination and review meetings.
7. Respond to Commissioning Team design submission review comments and other issues in a timely manner.
8. Attend the pre-bid and pre-construction meetings as scheduled by the Commissioning Authority.
9. Specify and verify that the operation and maintenance of the systems and assemblies has been adequately detailed in the Construction Documents.
10. Review and incorporate as appropriate the Commissioning Authority's comments from submittal reviews.

11. Participate in the initial operation and maintenance personnel and occupant training session by presenting the project Basis of Design.
12. Participate in other training as detailed in the training program.
13. Review test procedures submitted by the contractor.
14. Review and comment on the Commissioning Authority's periodic Commissioning Process Progress Reports and Issues Log reports.
15. Review and accept record documents as required by Contract Documents.
16. Review and comment on the final Commissioning Process Report.
17. Recommend final acceptance of the systems to the owner.

#### **CONSTRUCTION MANAGER**

1. Include costs for Commissioning Process activities in the contract price.
2. Include Commissioning Process requirements and activities in all contractors' contracts.
3. Provide adequate accessibility as required to properly operate and maintain the facility.
4. Provide acceptable representation with the means and authority to prepare and coordinate implementation of the Commissioning Process as detailed in the Contract Documents.
5. Issue a statement certifying that all work has been completed and that the facility is operational, in accordance with Contract Documents.
6. Issue the appropriate final reports to the design professionals for review and acceptance.
7. Remedy deficiencies identified by the Commissioning Authority during verification of the installation or testing.
8. Review and comment on the final Commissioning Process Report.

#### **CONTRACTOR**

1. Include costs for Commissioning Process activities in the contract price.
2. Include Commissioning Process requirements and activities in each purchase order or subcontract written.
3. Obtain cooperation and participation of all subcontractors and manufacturers.
4. Attend the pre-construction and Commissioning Team meetings.
5. Include Commissioning Process milestones in the project schedule.
6. Implement the training program as detailed in the Contract Documents.
7. Provide submittals to the owner, design professionals, and the Commissioning Authority.
8. Notify the Commissioning Authority when systems and assemblies are ready for testing.

9. Demonstrate the performance of assemblies and/or operation of systems to the Commissioning Authority.
10. Complete the Construction Checklists as the work is accomplished. Provide the completed Construction Checklists to the Commissioning Authority.
11. Continuously maintain the Record Drawings and submit as detailed in the Contract Documents.

#### **MANUFACTURERS**

1. Provide all information required for the operation and maintenance of the system or assembly as part of the initial submittal.
2. Provide the requirements to maintain the warranty as part of the initial submittal.
3. Coordinate and accomplish factory tests as detailed in the Contract Documents.
4. Provide training as detailed in the training program contained in the Contract Documents.
5. Demonstrate operation and performance of the system or assembly as detailed in the Contract Documents.

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### **INFORMATIVE ANNEX G COMMISSIONING PLAN**

*This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.*

The following is an example outline for a Commissioning Plan. The basic structure of this example is such that each phase of the plan has its own section detailing what activities will be accomplished and guidance on who accomplishes them and how they are completed. The results from each activity are then included in an appendix. The intent of this format is for the Commissioning Plan to become the Final Commissioning Process Report at the end of the project by filling in the results as the project progresses.

Depending upon the size and scope of the Commissioning Process activities, it may be beneficial to have three Commissioning Plans: one for the Pre-Design Phase, one for the Design Phase, and one for the Construction Phase. If separate Commissioning Plans are used, then care must be taken to inform those that are involved in only a portion of the process of the previous material.

#### **SAMPLE TABLE OF CONTENTS**

COMMISSIONING PLAN OVERVIEW  
COMMISSIONING PROCESS DESCRIPTION  
PRE-DESIGN PHASE

*Develop Owner's Project Requirements*

*Develop Initial Commissioning Plan*  
*Commissioning Process Issues*  
Step 1 - Identify and Record Issues  
Step 2 - Calculate Avoided Costs  
Step 3 - Evaluate Range of Avoided Costs

#### DESIGN PHASE

*Review and Modify Project Specifications*  
*Verify Basis of Design*  
*Update Commissioning Plan*  
*Accomplish Design Reviews*  
*Develop Commissioning Process Contract Document Requirements*  
*Pre-Bid Meeting*

#### CONSTRUCTION PHASE

*Conduct Pre-Construction Meeting*  
*Contractor Submittal Review*  
*Construction Checklists*  
Delivery Book  
Pre-Installation Checks  
Installation and Start-Up Checks  
*Training*  
*Testing*

#### OCCUPANCY AND OPERATIONS PHASE

*Final Commissioning Process Report*  
*Seasonal Testing*  
*Ongoing Training*  
*Warranty Review*  
*Lessons-Learned Meeting*

#### CONTACT INFORMATION

#### SCHEDULE REQUIREMENTS

#### APPENDIX A - OWNER'S PROJECT REQUIREMENTS

#### APPENDIX B - BASIS OF DESIGN

#### APPENDIX C - PROJECT SPECIFICATIONS

#### APPENDIX D - COMMUNICATION STRUCTURES

#### APPENDIX E - ROLES AND RESPONSIBILITIES

#### APPENDIX F - COMMISSIONED SYSTEMS [listing of systems and assemblies]

#### APPENDIX G - COMMISSIONING PROCESS SCHEDULE

#### APPENDIX H - PRE-BID MEETING

#### APPENDIX I - PRE-CONSTRUCTION MEETING

#### APPENDIX J - SUBMITTAL REVIEW

#### APPENDIX K - COMMISSIONING PROCESS ISSUES

#### APPENDIX L - CONSTRUCTION CHECKLISTS

#### APPENDIX M - TESTS

#### APPENDIX N - TRAINING

#### APPENDIX O - SYSTEMS MANUAL

#### APPENDIX P - MEETING MINUTES

#### APPENDIX Q - CORRESPONDENCE

#### APPENDIX R - WARRANTY REVIEW

#### APPENDIX S - LESSONS LEARNED

**(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)**

### INFORMATIVE ANNEX H ACCEPTANCE PLAN

*This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.*

Developing and documenting the acceptance procedures in an acceptance plan is an important task for the successful implementation of the Commissioning Process. The acceptance plan details the key Commissioning Process activities that must be accomplished at the end of each phase in a project in order to move on to the next phase.

The following provides a description of the details that should be included in the acceptance plan and demonstrates a format that could be used.

#### PRE-DESIGN PHASE

The Owner's Project Requirements and the Commissioning Plan are formally accepted by the Owner during the Pre-Design Phase, after review and comment by the Commissioning Authority. The general process for accepting these documents is:

1. The Commissioning Authority develops a draft of each document and provides it to the Commissioning Team.
2. The Commissioning Team provides comments on the draft documents.
3. The Commissioning Authority works with the Commissioning Team to resolve any issues.
4. The Commissioning Authority recommends acceptance of the documents to the Owner and provides copies for review.
5. The Owner reviews the modified documents and accepts.

#### DESIGN PHASE

Updated Owner's Project Requirements, updated Commissioning Plan, Basis of Design, and Contract Documents are formally accepted by the Owner during the Design Phase. The Owner's Project Requirements and the Commissioning Plan follow the same process as detailed in the Pre-Design Phase.

The general process for accepting the Basis of Design is:

1. The Commissioning Authority provides a list of information required and the format for the Basis of Design to the design professionals prior to the start of design.
2. The design professionals gather and organize the information during the creation of the design.
3. The design professionals submit the Basis of Design to the Owner and Commissioning Authority for review and comment with each design submittal.

4. Upon correction and resubmittal, the Owner accepts the Basis of Design based upon the recommendation of the Commissioning Authority.

The general process for accepting the Contract Documents is:

1. The design professionals submit the final package to the Owner and Commissioning Authority for review.
2. The Commissioning Authority evaluates the Contract Documents using random sampling to determine their ability to achieve the Owner's Project Requirements.
3. The Commissioning Authority meets with the design professionals to discuss and resolve comments.
4. Upon resolution of comments, the Commissioning Authority recommends to the Owner acceptance of the documents.
5. Owner reviews the comments, their resolution, and accepts the Contract Documents.

## CONSTRUCTION PHASE

Updated Owner's Project Requirements, updated Commissioning Plan, updated Basis of Design, Systems Manual, training program, and a preliminary and a final Construction Phase Commissioning Process Report are formally accepted by the Owner during the Construction Phase. The Owner's Project Requirements, Commissioning Plan, and Basis of Design follow the same process as previously detailed.

The general process for accepting the Systems Manual is:

1. The Commissioning Authority tracks the Contractor submittals for the required documentation.
2. Within XX days of submittal acceptance for a system or assembly, the Contractor submits a draft Systems Manual to the Owner, Commissioning Authority, and design professionals.
3. The Commissioning Authority consolidates the reviews and meets with the design professionals to discuss and resolve.
4. The Contractor submits to the Commissioning Authority changes to the accepted submittals throughout construction.
5. XX days prior to the first training session, the Contractor submits the final Systems Manual to the Owner, Commissioning Authority, and design professionals.
6. The Owner accepts the final Systems Manual based upon the recommendation of the Commissioning Authority.

The general process for accepting the training program is:

1. The Commissioning Authority provides the training agenda to the Contractor.
2. The Contractor develops the training program, including identifying the trainer, the schedule of sessions, and the material to be developed. This information is submitted to the Owner, Commissioning Authority, and design professionals for review and comment.
3. Based upon the recommendation of the Commissioning Authority, the Owner accepts the training program.

4. The Contractor then develops the training material and submits it to the Owner, Commissioning Authority, and design professionals for review and comment XX days prior to the first training session.
5. Based upon the recommendation of the Commissioning Authority, the Owner accepts the training materials.
6. The Contractor implements the training program.
7. The Commissioning Authority randomly quizzes the trainees two weeks after the completion of a session.
8. The Contractor submits copies of all training materials and edited videotapes of the sessions.
9. The Commissioning Authority recommends acceptance of the completed training program to the Owner.

The general process for accepting the facility is:

1. Throughout construction the Commissioning Authority randomly samples the completion of the Construction Checklists for achieving the Owner's Project Requirements.
2. The Commissioning Authority directs the completion of system and assembly testing by the Contractor and documents the results.
3. The Commissioning Authority works with the Contractor in resolving any issues identified during testing.
4. The Commissioning Authority verifies that all system documentation is received from the Contractor.
5. The Commissioning Authority presents a preliminary Construction Phase Commissioning Process Report prior to occupancy that provides an evaluation of achieving each element of the Owner's Project Requirements, including recommendations to the Owner for acceptance/rejection of the facility.
6. The Commissioning Authority provides a final Construction Phase Commissioning Process Report with details on the Commissioning Process Activities completed during the Construction Phase.

## OCCUPANCY AND OPERATIONS PHASE

Updated Owner's Project Requirements, updated Basis of Design, updated Systems Manual, seasonal test results, and Commissioning Process Report are formally accepted by the Owner during the Occupancy and Operations Phase. The Owner's Project Requirements, Basis of Design, and Systems Manual follow the same process as previously detailed.

The general process for accepting the seasonal test results is:

1. The Commissioning Authority directs the completion of seasonal system and assembly testing by the Contractor and documents the results.
2. The Commissioning Authority works with the Contractor in resolving any issues identified during testing.
3. The Commissioning Authority verifies that all updated system documentation is received from the Contractor.
4. The Commissioning Authority recommends to the Owner acceptance of the seasonal testing results.

The general process for accepting the Commissioning Process Report is:

1. The Commissioning Authority provides the Commissioning Process Report to the Owner, design professionals, and Contractor for review and comment.
2. The Commissioning Authority incorporates comments and provides a final copy to the Commissioning Team members.
3. The Owner accepts the Commissioning Process Report, ending the Commissioning Authority's responsibilities.

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## **INFORMATIVE ANNEX I OWNER'S PROJECT REQUIREMENTS WORKSHOP GUIDANCE**

*This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.*

The Owner's Project Requirements are considered the heart and soul of the Commissioning Process. When the Owner's Project Requirements are not developed, the owner, designer, contractors, and operation and maintenance (O&M) personnel each interpret the building requirements, including their individual responsibilities, from the standpoint of their own specific needs. This often creates a range of diverse views of the constructed project's needs. Unfortunately, while critical for a successful project, the Owner's Project Requirements are rarely developed. Developing Owner's Project Requirements that reflect the actual needs of the owner, the users or occupants, service and operating units, and sometimes the community is one of the, if not the, most important aspects for successful implementation of the Commissioning Process.

The following sections detail an example format to follow in developing the Owner's Project Requirements and a discussion of how to obtain the required information. Note that historically the Owner's Project Requirements have often been referred to as "design intent" or "project intent."

### **FORMAT**

While there have been many formats used for presenting criteria for the Owner's Project Requirements, the Owner's Project Requirements workshop is one that has been well received by owners, designers, contractors, and O&M personnel. The workshop initially addresses general needs/requirements and progresses to specific requirements (i.e., moves from project needs to system/equipment/control needs). It is organized around and focuses upon assemblies and systems that have been identified as targets of the Commissioning Process. The workshop needs to be well organized, and it is very desirable to have the results formatted for immediate input into a computer analysis program for rapid feedback on consensus of the group.

Information from the workshop is only one of various resources from which the Owner's Project Requirements document is developed. Following is a description of some of the information that can be included in an Owner's Project Requirements document.

Key sections of the Owner's Project Requirements document are:

- **Background** – A narrative description to provide context about the project.
- **Objectives** – For any project there are goals that must be achieved for the project to be successful. Goals can range from first cost, to time schedule, to number of change orders, or to life-cycle cost. Regardless of which goals are identified, they must be summarized up front to ensure everyone is on the same page.
- **Green building concepts** – This is an optional section for owners who wish to focus upon the sustainability aspects of their building.
- **Functional uses and requirements** – In addition to general documentation produced by the architect on functional uses of the building (office, storage, kitchen, etc.), the specific requirements for each functional area must be documented. This can include such items as security, safety, comfort, energy, maintainability, and indoor air quality.
- **Lifespan, cost, and quality** – It is important to clearly document the owner's expectations for lifespan of materials, cost of construction, and the level of quality desired. By providing this information, unrealistic expectations are identified and eliminated.
- **Performance criteria** – Often the most difficult to define, performance criteria detail minimum acceptable performance benchmarks for various aspects of the facility.
- **Maintenance requirements** – The maintenance requirements are a mixture of the level of knowledge of the current O&M staff (what can they maintain) and the expected complexity of the proposed systems (what they can learn). If there is a significant gap between the two, no matter how well the building is constructed, it will not be maintained or operated properly.

The following are examples of Owner's Project Requirements elements that are common to most of the Technical Commissioning Process Guideline topics;

- **Benchmarks for performance** – Specific criteria for the functional use of each space, assembly, and system must be defined. These include temperature, humidity, air-flow, light, noise, durability, aesthetics (materials and colors), service life, reliability, redundancy, and the like. Typically, upper and lower limits are provided for general spaces, with exceptions noted as required.
- **Problems to avoid** – Since occupant/user/operator complaints are common, it is important to identify and document those problems that have caused complaints in the past. If these problems are not documented and the situation recurs, the occupants often consider the entire project as a failure.

- Specific occupant requirements – Specific items that are deemed important to the various occupants in a building must be identified and documented. In speculatively built buildings, this section would detail the limits to which occupants can make use of their spaces. For example, a chemical laboratory cannot be put in a space designed and constructed for general office use without significant changes to the systems and possibly to the building as a whole.

## OBTAINING THE INFORMATION

While it may be easy to obtain the information related to development of the Owner's Project Requirements, it is difficult to obtain quality information that the owner, O&M staff, service contractors, customers (i.e., students, patients, retail customers, renters), visitors, subtenants, occupants, and the community all agree upon. In quality-based processes, it is critical that input be obtained from all the users (the various user groups) and that the consensus of and differences between the groups be documented. There usually are requirements for which users do not all agree. These must be documented as unresolved items. Normally, the owner will make final decisions on what the priority order of Owner's Project Requirements will be. However, the owner and the rest of the Commissioning Team must be aware of all requirements so that the final product will include as many individual group requirements as are deemed appropriate and within the budget.

A simple three-step process is recommended for developing the Owner's Project Requirements:

1. Owner's Project Requirements workshop.
2. Owner's Project Requirements documentation (report).
3. Project team approval of the Owner's Project Requirements.

## Owner's Project Requirements Workshop

The Owner's Project Requirements workshop is typically facilitated by the Commissioning Authority (CxA), who elicits the primary concerns of the project team. The workshop is organized to encourage identification of all requirements, to encourage interaction and discussion among all team members, and to arrive at group consensus of priorities for the Owner's Project Requirements. This is accomplished through the presentation of multiple questions in an ordered structure. A typical process uses a modified Nominal Group Technique workshop format. This is a formal means of gathering the highest level of consensus that approaches the real needs of the group. The procedure consists of the following steps:

- Provide each question or open concept to each individual participating in the workshop.
- Allow three to five minutes of quiet writing time for each individual to respond with as many answers and ideas as he/she can.
- Record individual responses in a round-robin fashion – no discussion at this point, just record the responses on a visual flipchart, overhead, chalkboard, or multi-computer link to all participants.

- Review all responses, consolidate similar ones, and clarify so all in the group have the same understanding of all responses.
- Have individuals rank the responses for importance (1 through 5).
- Determine a group ranking from individual rankings.
- A re-discussion of the top 10 items—and any responses ranked most important—is desired, followed by a second round of individual and group combined rating/ranking.

The questions asked during this workshop must be broad in nature, elicit discussion, result in a variety of viewpoints, and must not leave the workshop. The questions should not focus on such items as “at what temperature are you comfortable?” but should be broader, such as “how do you define comfort?” or “how will you measure the cost success of this project?” (versus a broader question, such as “how will you determine if this was a successful project?”).

## Owner's Project Requirements Documentation

The Owner's Project Requirements workshop will identify key items and priorities important to the project team, the owner, users, and the Commissioning Team. However, it does not provide specific values. For example, the number one Owner's Project Requirement may be good air circulation in the rooms. It is the responsibility of the Commissioning Authority to take the individual requirements developed by the project team and translate them into physical properties that can be measured, designed, and documented.

This transformation of the Owner's Project Requirements often requires input from a variety of sources, including the design team, contractors, specialists, standards, and guidelines. Typically, the Commissioning Authority has sufficient experience in the planning, design, construction, and operation of facilities to provide the oversight of such a task. If not, then experts should be retained to aid in the development of the Owner's Project Requirements.

## Project Team Approval of the Owner's Project Requirements

After several iterations and reviews of the Owner's Project Requirements by the project and design teams, the requirements must be approved to provide the design team adequate direction for their design. It is important to distinguish development of the Owner's Project Requirements from the traditional role of the architect in the planning or programming process. The Owner's Project Requirements define the criteria required for success, whereas the architect's document may only address specific space size and occupant flow requirements. Where the Owner's Project Requirements may state that the functional use of the facility is X, Y, and Z, the architect's document may specify the locations of, the size of, and the flow of people through X, Y, and Z.

## SUMMARY

The Owner's Project Requirements workshop is one means to provide consistency in the implementation of the Commissioning Process from project to project. It should be a topic addressed in the lessons-learned workshop during the

Occupancy and Operations Phase of the Commissioning Process. Other techniques for developing the Owner's Project Requirements, such as interviews and surveys, do not allow interaction between the user groups. Further, it has been shown that the results or answers are biased by the beliefs of the expert who develops the questions for the interviews or surveys. Frequently, using such techniques the questions can be analyzed and the conclusions pre-determined whether the interviews or surveys are completed or not.

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**(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)**

## **INFORMATIVE ANNEX J OWNER'S PROJECT REQUIREMENTS**

*This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.*

A general format for an Owner's Project Requirements document is presented in this annex. The structure provided is intended to encompass the facility requirements and enable the addition of sections depending upon the systems and assemblies to be constructed.

**Introduction** – Includes an overview of the project and the general reasons why the project is being undertaken. A description of the owner's processes (Commissioning Process) is typically contained in this section.

**Key Owner's Project Requirements** – Includes a listing of the key Owner's Project Requirements that the Commissioning Process will focus upon and that the owner (Commissioning Team) has determined are critical to the success of the project.

**General Project Description** - The size and scope of the project are included in this section.

**Objectives** – The objectives for accomplishing this project are detailed in this section.

**Functional Uses** – The expected functional uses (spaces) for the facility are detailed in this section. A short description of each functional use is included to provide the context in which it was detailed.

**Occupancy Requirements** – Includes the number of occupants (users and visitors) and the schedule of occupancy, including all special conditions.

**Budget Considerations and Limitations** – The expected budgetary restrictions and considerations are contained in this section.

**Performance Criteria** – The performance criteria upon which the project will be evaluated by the Commissioning Team are included in this section. Each performance criterion should be measurable and verifiable. Include subsections as appropriate to organize and explain the criteria:

- General
- Economic
- User Requirements
- Construction Process
- Operations
- Systems
- Assemblies

**Owner's Project Requirements Version History** – Includes a summary of the changes made throughout the Pre-Design, Design, Construction, and Occupancy and Operations Phases. This information is critical to understand and document the trade-offs made over time and the resulting impact on the project.

The following table will assist in the development of the Owner's Project Requirements document in accordance with Section 5.2.2.4 using the format presented in this annex. The table is also applicable for those developing Technical Supporting Guidelines as described in Annex A. Inclusion of specific criteria (such as the entries in this example matrix) will depend upon the project and the owner's needs. The Key Owner's Project Requirements Section should emphasize those OPR that are essential to the success of the project.

**TABLE J-1 Example Matrix for Developing Owner's Project Requirements**

	Guideline 0-2005 Subclause 5.2.2.4 Criteria	OPR Document Section							
		Introduction	Key Owner's Project Requirements	General Project Description	Objectives	Functional Uses	Occupancy Requirements	Budget Considerations and Limitations	
		1	2	3	4	5	6	7	
(a)	Project schedule and budget			Schedule				Budget	
(b)	Commissioning Process scope and budget	Scope						Budget	
(c)	Project documentation requirements, including format for submittals, training materials, reports, and the Systems Manual. Consideration should be given to use of electronic format documents and records where appropriate		X						
(d)	Owner directives		X						
(e)	Restrictions and limitations			X					
(f)	User requirements		X						
(g)	Occupancy requirements and schedules					X	X		
(h)	Training requirements for Owner's personnel		X						
(i)	Warranty requirements		X						
(j)	Benchmarking requirements		X						
(k)	Operation and maintenance criteria for the facility that reflect the Owner's expectations and capabilities and the realities of the facility type		X						
(l)	Equipment and system maintainability expectations, including limitations of operating and maintenance personnel		X		X				
(m)	Quality requirements for materials and construction		X						
(n)	Allowable tolerance in facility system operations				X				
(o)	Energy efficiency goals		X		X				
(p)	Environmental and sustainability goals		X		X				
(q)	Community requirements		X						
(r)	Adaptability for future facility changes and expansion		X		X	X			
(s)	Systems integration requirements, especially across disciplines					X			
(t)	Health, hygiene, and indoor environment requirements		X				X		
(u)	Acoustical requirements		X						
(v)	Vibration requirements		X						
(w)	Seismic requirements		X						
(x)	Accessibility requirements		X						
(y)	Security requirements		X						
(z)	Aesthetics requirements		X						
(aa)	Constructability requirements		X						
(bb)	Communication requirements		X						
(cc)	Applicable codes and standards			X					

**TABLE J-1 (Continued) Example Matrix for Developing Owner's Project Requirements**

	Guideline 0 Body	OPR Document Section							
		Performance Criteria							OPR Version History
		General	Economic	User Requirements	Construction Process	Operations	Systems	Assemblies	
		8	9	10	11	12	13	14	
(a)	Project schedule and budget								
(b)	Commissioning Process scope and budget								
(c)	Project documentation requirements, including format for submittals, training materials, reports, and the Systems Manual. Consideration should be given to use of electronic format documents and records where appropriate								
(d)	Owner directives								
(e)	Restrictions and limitations								
(f)	User requirements			X					
(g)	Occupancy requirements and schedules								
(h)	Training requirements for Owner's personnel				X	X			
(i)	Warranty requirements					X			
(j)	Benchmarking requirements		X		X	X	X		
(k)	Operation and maintenance criteria for the facility that reflect the Owner's expectations and capabilities and the realities of the facility type					X	X	X	
(l)	Equipment and system maintainability expectations, including limitations of operating and maintenance personnel				X	X	X		
(m)	Quality requirements for materials and construction	X			X		X	X	
(n)	Allowable tolerance in facility system operations					X	X		
(o)	Energy efficiency goals		X			X	X	X	
(p)	Environmental and sustainability goals	X							
(q)	Community requirements	X							
(r)	Adaptability for future facility changes and expansion				X	X	X	X	
(s)	Systems integration requirements, especially across disciplines	X			X				
(t)	Health, hygiene, and indoor environment requirements			X					
(u)	Acoustical requirements	X		X	X				
(v)	Vibration requirements	X			X				
(w)	Seismic requirements	X			X				
(x)	Accessibility requirements	X		X	X	X			
(y)	Security requirements	X		X	X				
(z)	Aesthetics requirements	X		X	X				
(aa)	Constructability requirements	X			X				
(bb)	Communication requirements	X		X	X				
(cc)	Applicable codes and standards								

**(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)**

## **INFORMATIVE ANNEX K BASIS OF DESIGN**

*This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.*

The Basis of Design document records the major thought processes and assumptions behind design decisions made to meet the Owner's Project Requirements. The Owner's Project Requirements are intended to capture "what" the owner needs and expects from a project. The Construction Documents detail "how" the Owner's Project Requirements will be physically achieved. The Basis of Design captures important information linking the "what" and "how."

Basis of Design documentation is distinct from the Construction Documents, is seldom included in drawings and specifications, and is generally not needed by the Contractor to meet his/her obligations. It is exceptionally valuable to the Commissioning Team, however, when evaluating the ability of a design and its components to meet the Owner's Project Requirements.

The objective of specifically documenting Basis of Design information is to provide the parties involved with a project, at each phase in the process, an understanding of the underlying thinking that led to the selection of specific components, assemblies, systems, and system integrations. A design narrative that provides an overview of assemblies and systems in verbal format is usually an integral element of the Basis of Design.

The Basis of Design document will typically be developed incrementally as work on a project moves from Pre-Design, to Design, and into the Construction Phase. Changes to the Basis of Design that often occur as a design evolves must be documented.

Content of the Basis of Design document will vary from project to project and system to system, but in general it should address the following:

- Specific codes, standards, and guidelines considered during design of the facility and designer interpretations of such requirements.
- Information regarding ambient conditions (climatic, geologic, structural, existing construction) used during design.
- Assumptions regarding usage of the facility.
- Expectations regarding system operation and maintenance.
- Performance criteria that the system was designed to meet – linked to the Owner's Project Requirements.
- Specific design methods, techniques, software used in design.
- A narrative statement of design – that verbally describes how the designer intends to meet the Owner's Project Requirements.

- A narrative statement of operation – that verbally details how the facility is expected to operate under various situations (such as normal operation, extreme event, emergency).
- A listing of specific manufacturer makes and models used as the basis for drawings and specifications.

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**(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)**

## **INFORMATIVE ANNEX L SPECIFICATIONS**

*This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.*

### **1. SPECIFICATIONS FOR THE COMMISSIONING PROCESS**

**1.1** This annex provides guidance on writing specifications for Commissioning Process activities to be performed by construction contractors. A guide specification is included with the assumption that the construction contractor is involved only during the construction phase and for the correction and warranty period.

**1.2** Commissioning is a quality-oriented process for achieving, verifying, and documenting that the performance of facility systems and assemblies meets defined objectives and criteria. The Commissioning Process begins at project inception during the Pre-Design Phase and continues for the life of the facility through the Occupancy and Operations Phase. During the Pre-Design Phase, the Owner's Project Requirements (OPR) are determined and documented by the Commissioning Team, which includes the Owner, Commissioning Authority (CxA), design professionals, operation and maintenance personnel, occupants, and users. Throughout each phase of the project, deliverables (drawings, specifications, submittals, construction, training, documentation, etc.) are verified against the OPR.

**1.3** An important document created during the Commissioning Process is the Basis of Design document or report (BoD). The design professionals create this document or report during the design phase. The BoD records the concepts, calculations, decisions, and product selections to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. It can include energy, environmental, sustainability, and other certification criteria, both formal and informal. The BoD includes both narrative descriptions and lists of individual items that support the design process.

**1.4** ASHRAE or NIBS Guideline 0 provides guidance on content and basic format. While the OPR are Owner-developed criteria, few Owners have the resources to develop the

OPR. Owners without these resources depend on the Commissioning Team (see a definition and discussion of the term *Commissioning Team* in this guideline) to assist them in developing the OPR.

**1.5** The OPR and BoD must be included or referenced in the construction Contract Documents for informational purposes only.

**1.6** The construction contractor's obligation is to construct the building and its systems and assemblies according to the requirements prescribed in the Contract Documents. There normally are no performance requirements relating to the OPR stated in the Contract Documents. The exceptions to this include situations where contractors are required to provide designs for systems or assemblies to be signed and sealed by licensed professionals.

## **2. THE COMMISSIONING AUTHORITY (CxA)**

**2.1** The primary role of the CxA is to verify achievement of the OPR throughout the project, from Pre-Design Phase through Occupancy and Operations Phase. The Owner should perform this role.

**2.2** When the Owner cannot perform the CxA duties with qualified personnel, then the CxA should have a separate professional services agreement with the Owner, as this avoids conflicts of interest and provides independence from the other parties (the Owner's project manager, designers of record, construction managers, suppliers, and construction contractors). This professional services agreement defines the duties, rights, and responsibilities of the CxA for each phase of the project. This separate relationship allows the CxA to act independently as director of Commissioning Process activities, to focus on achieving the OPR, and to communicate directly with the Owner.

**2.3** The CxA is a group of personnel with expertise and experience in the design, construction, and operations of the various systems and assemblies included in the project. These personnel are led by an individual who has expertise and experience in successfully implementing the Commissioning Process.

**2.4** If the CxA is an employee, associate, or partner of the same organization as the designer of record or construction management firm, there is a conflict of interest. While not a recommended approach, in these instances the CxA must have a separate professional services agreement, be organizationally separate from the design team or construction management team, and define and manage the conflicts of interest

to provide the Owner with the independence required for the Commissioning Process to be successful.

**2.5** The CxA does not perform testing; it directs the process and directs the recording of the results. The CxA plans, schedules, and supervises Commissioning Process activities to verify achievement of the OPR. The Contractor completes construction checklists, performs tests, and accomplishes other Commissioning Process activities.

## **3. ORGANIZATIONAL STRATEGY FOR INCLUSION OF COMMISSIONING ACTIVITIES IN THE SPECIFICATIONS**

**3.1** Specifications (as a part of the construction Contract Documents) should include only the Commissioning Process activities the contractors perform during the life of the construction contract, including the work required during the correction period and for warranties.

**3.2** *Supplementary Conditions*: Modify the General Conditions of the Contract for Construction in a document titled "Supplementary Conditions." Among other provisions, define the CxA and include the CxA's duties, rights, responsibilities, and limits of authority and additional requirements for substantial completion. AIA Document A511, "Guide for Supplementary Conditions," provides guidance about how to write Supplementary Conditions.

**3.3** *General Requirements for the Commissioning Process*: Specifications in Division 1 include the general requirements for contractors relating to Commissioning Process activities. The "Summary" Section describes, in general, how the Contractors, separate Contractors (if there is more than one Prime Contractor), or the Construction Manager must interact with the CxA. Administrative procedures for the Commissioning Process are specified in the Division 1 Section "Commissioning."

**3.3.1** The remainder of the specification language, with the exception of Division 1 sections for temporary facilities and controls, should be mute on the subject of who must perform the work.

**3.3.2** Other Division 1 Commissioning Sections should describe the testing requirements for systems and assemblies.

**3.3.2.1** References in Table L-1 are to MASTER-SPEC® section numbers and titles existing at the time this annex was written. Refer to the current MASTERSPEC consolidated table of contents because section numbers and titles may have changed.

**TABLE L-1 Description of Specification Sections**

SEC NO.	DOCUMENT/SECTION	LIST OF CONTENTS	SCOPE OF CONTENTS
01100	SUMMARY	<p>Work covered by Contract Documents</p> <p>Identification of separate prime contractors</p>	<p>Describe Commissioning Process activities as a part of the project.</p> <p>Alert the Contractor that the Owner has contracted for commissioning with a separate Commissioning Authority.</p> <p>Delineate scope of Commissioning Process.</p>
01290	PAYMENT PROCEDURES		No special Commissioning Process requirements.
01310	PROJECT MANAGEMENT AND COORDINATION	Provisions about coordination of Commissioning Process activities among contractors and sub-contractors; project meetings.	Add requirements to include CxA in coordination meetings (particularly “Pre-Construction Meeting”). Coordination of meetings and conferences.
01330	SUBMITTAL PROCEDURES	Procedures for submittals	<p>Submittal requirements for Commissioning Process activity reports and schedules should be specified in Sections 01811 to 01819.</p> <p>Add requirements here for additional copies from Contractor to CxA and for approved submittals to be distributed to CxA.</p>
01400	QUALITY REQUIREMENTS		Coordinate with Commissioning Process activities, witnessing of tests, and test reports.
01500	TEMPORARY FACILITIES AND CONTROLS		Include office space for CxA and utility services for Commissioning Process activities.
01600	PRODUCT REQUIREMENTS		No special Commissioning Process requirements.
01731	CUTTING AND PATCHING		No special Commissioning Process requirements.
01770	CLOSEOUT PROCEDURES		Include key Commissioning Process milestones to achieve substantial completion and closeout.
01782	OPERATION AND MAINTENANCE DATA		<p>Include requirements for CxA to review and recommend approval of Systems Manual.</p> <p>Same procedures as described for Section 01330—Submittals.</p>
01810	GENERAL COMMISSIONING REQUIREMENTS		General administrative and procedural requirements without regard to specific systems and assemblies.
01811	BUILDING ASSEMBLY COMMISSIONING REQUIREMENTS	<p>Substructure</p> <p>Superstructure</p> <p>Building Shell</p> <p>Exterior Wall Assemblies</p> <p>Roof Assemblies</p> <p>Building Interior</p> <p>Separations</p> <p>Paths of Egress</p>	<p>Lists of Construction Checklists</p> <p>Prerequisites to Testing</p> <p>System or Assembly Test Requirements</p> <p>Test Reports</p>
01812	CONVEYING SYSTEM COMMISSIONING REQUIREMENTS	<p>Elevators and Lifts</p> <p>Escalators and Moving Walks</p>	<p>Lists of Construction Checklists</p> <p>Prerequisites To Testing</p> <p>System or Assembly Test Requirements</p> <p>Test Reports</p>
01813	PROTECTIVE SYSTEM COMMISSIONING REQUIREMENTS	<p>Fire Suppression (including pumps, sprinkler and standpipe piping, and terminal devices)</p> <p>Detection and Alarms (including fire, smoke, gas, and leak)</p> <p>Lightning Protection (this is not part of electrical distribution)</p> <p>Cathodic Protection (this is not part of electrical distribution)</p>	<p>Lists of Construction Checklists</p> <p>Prerequisites to Testing</p> <p>System or Assembly Test Requirements</p> <p>Test Reports</p>

**TABLE L-1 (Continued) Description of Specification Sections**

SEC NO.	DOCUMENT/SECTION	LIST OF CONTENTS	SCOPE OF CONTENTS
01814	PLUMBING SYSTEM COMMISSIONING REQUIREMENTS	Water Distribution Sanitary Waste Storm Drainage Other Plumbing Systems	Lists of Construction Checklists Prerequisites to Testing System or Assembly Test Requirements Test Reports
01815	HVAC&R SYSTEM COMMISSIONING REQUIREMENTS	Heat Generation (including central equipment, distribution systems, and terminal devices) Refrigeration (including central equipment, distribution systems, and terminal devices) Ventilation (including central equipment, distribution systems, and terminal devices) HVAC Control Systems (including central equipment, distribution systems, and terminal devices)	Lists of Construction Checklists Prerequisites to Testing System or Assembly Test Requirements Test Reports
01816	ELECTRICAL SYSTEM COMMISSIONING REQUIREMENTS	Power Distribution (including central equipment, distribution circuits, and terminal devices) Lighting (includes fixtures and controls)	Lists of Construction Checklists Prerequisites to Testing System or Assembly Test Requirements Test Reports
01817	COMMUNICATIONS SYSTEMS COMMISSIONING REQUIREMENTS	Voice and Data Sound and Video	Lists of Construction Checklists Prerequisites to Testing System or Assembly Test Requirements Test Reports
01818	ELECTRONIC SAFETY AND SECURITY SYSTEMS COMMISSIONING REQUIREMENTS	Security Access, Perimeter Security, Intrusion Detection, Alarm and Detection Systems (including fire and smoke and leak detection)	Lists of Construction Checklists Prerequisites to Testing System or Assembly Test Requirements Test Reports
01820	DEMONSTRATION		Coordination requirements with the CxA
	INDIVIDUAL SECTIONS IN DIVISIONS 2 THROUGH 16	Field Quality Control Tests Adjusting and Balancing Cleaning Demonstration	A statement requiring system, subsystem, or equipment to be commissioned as a part of its parent system. A statement requiring Contractor to complete construction checklists and perform tests.

**3.3.3 Extent of Testing:** The contractor's involvement in Commissioning Process tests must be clearly defined. The extent of this testing is determined by the Commissioning Team during the Design Phase based upon the OPR.

**3.4 Component Commissioning Process Specifications:** Sections in Divisions 2 through 16 should specify testing and reporting requirements for products and equipment that are part of a system or assembly and then be referenced to the appropriate Commissioning Process sections in Division 1 for the overall system or assembly requirements.

**3.4.1** During construction the CxA verifies that contractor activities, such as installation and start-up; testing; demonstration and training of the Owner's operator and maintenance personnel; and Systems Manual, achieve the OPR. Coordinating activities by the contractor in support of the CxA should be specified within the section where the component is specified (i.e., in individual sections in Divisions 2 through 16) if special requirements are necessary. The following are examples of requirements to include in individual sections in Divisions 2 through 16:

**3.4.1.1 Installation and Start-up:** Include requirements for involvement of factory-authorized service representative in individual sections and for the completion of construction checklists.

**3.4.1.2 Testing:** Include requirements to support the CxA in verifying test results, ranging from coordinating testing, to witnessing the test, to utilizing contractor personnel and test equipment to verify the test report.

**3.4.1.3 Demonstration and Training:** Include special requirements unique to the component within its own section.

**3.4.1.4 Operation and Maintenance Data:** Include unique requirements for the type of information required (e.g., particular requirements about parts lists, service schedules, preventive maintenance lists, and emergency operations) for long-term maintenance of the OPR.

**3.4.2** In each section include an article under "General" that refers to Division 1 for Commissioning Process activities for system or assembly requirements. An example is as follows:

## 1.XX Commissioning Process Activities

- A. The roofing materials specified in this Section are included in the Commissioning Process as a part of the building envelope system and roofing subsystem and integrated with flashing, coping, and insulation.
- B. Complete the construction checklists and perform tests specified in the Division 1 Section “Building Assemblies Commissioning Requirements.”

## 4. INTRODUCTION TO GUIDE SPECIFICATIONS

This Specification Section was written in cooperation with Architectural Computer Services, Inc. (ARCOM), who are the exclusive publishers and distributors of MASTERSPEC, a product of the American Institute of Architects. MASTERSPEC Section 01 9113—General Commissioning Requirements—is included in Guideline 0 by special agreement between ASHRAE and ARCOM.

**4.1** The section includes boxed notes that are instructions to guide specifiers during editing of the specifications for a project.

**4.2** The section includes optional text in boldface font and square brackets (e.g., [**optional text**]). These optional text items include text that often occurs and provides an easy way to include these requirements in the master for consideration for each project.

**4.3** The section includes insert instructions in boldface font and angle brackets (e.g., <**Insert instructions**>). These instructions are placed where text must be inserted and provide some guidance about the nature of the text that must be inserted. Insert instructions are used when there are an infinite number of options that could occur making the use of [**Optional text**] impractical.

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## SECTION 01 9113 - GENERAL COMMISSIONING REQUIREMENTS

This Section uses the term “Architect.” Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Throughout the Section, the optional text “[**each** ]” is included with the term “Contractor.” Retain “each” for projects that include multiple prime contractors; delete for projects that have a single prime contractor.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

## 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.

Documents referenced in paragraph below should be prepared during schematic design phase or earlier and updated as design progresses. They should be provided to Contractor when the commissioning process is implemented on Project.

- B. OPR and BoD documentation are included by reference for information only.

### 1.2 SUMMARY

- A. This Section includes general requirements that apply to implementation of the commissioning process without regard to specific systems, assemblies, and components.
- B. Related Sections include the following:

List below only requirements that the reader might expect to find in this Section but are specified elsewhere. The first four and the last three subparagraphs are not yet available in MASTERSPEC but should be written and included if total building commissioning is implemented.

1. Division 01 Section "Facility Substructure Commissioning" for commissioning process activities for foundations and basement systems and assemblies.
2. Division 01 Section "Facility Shell Commissioning" for commissioning process activities for superstructure, exterior enclosure, and roofing systems and assemblies.
3. Division 01 Section "Interiors Commissioning" for commissioning process activities for interior construction, stairways, and interior finishes systems and assemblies.
4. Division 14 Section "Commissioning of Conveying Equipment" for commissioning process activities for dumbwaiters, elevators, escalators and moving walks, lifts, turntables, and scaffolding systems, assemblies, equipment, and components.
5. Division 21 Section "Commissioning of Fire Suppression" for commissioning process activities for fire suppression systems, assemblies, equipment, and components.
6. Division 22 Section "Commissioning of Plumbing" for commissioning process activities for plumbing systems, assemblies, equipment, and components.
7. Division 23 Section "Commissioning of HVAC&R" for commissioning process activities for commissioning heating, ventilating, air-conditioning, and refrigeration systems, assemblies, equipment and components.
8. Division 25 Section "Commissioning of Integrated Automation" for commissioning process activities for commissioning integrated automation systems, assemblies, equipment and components.
9. Division 26 Section "Commissioning of Electrical" for commissioning process activities for electrical systems, assemblies, equipment, and components.
10. Division 27 Section "Commissioning of Communications" for commissioning process activities for communication systems, assemblies, equipment, and components.
11. Division 28 Section "Commissioning of Electronic Safety and Security" for commissioning process activities for electronic safety and security systems, assemblies, equipment, and components.
12. Division 33 Section "Commissioning of Utilities" for commissioning process activities for water, wells, sanitary sewerage, storm drainage, fuel distribution, hydronic and steam energy, electrical, and communications utilities systems, assemblies, equipment, and components.

### 1.3 DEFINITIONS

Retain acronyms, abbreviations, and terms below that remain after this Section has been edited.

- A. BoD: Basis of Design. A document, prepared by Architect, that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions

and lists of individual items that support the design process.

- B. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- C. CxA: Commissioning Authority.
- D. OPR: Owner's Project Requirements. A document, prepared by Owner, that details the functional requirements of Project and expectations of how it will be used and operated. This document includes Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.
- E. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, equipment, and components.

### 1.4 COMMISSIONING TEAM

- A. Members Appointed by Contractor(s): Individuals, each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of [each] Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
- B. Members Appointed by Owner:
  1. CxA: An entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
  2. Representatives of the facility user and operation and maintenance personnel.
  3. Architect and engineering design professionals.

### 1.5 OWNER'S RESPONSIBILITIES

- A. Provide the OPR documentation to the CxA and [each] Contractor for information and use.
- B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.

Coordinate activities specified in paragraph below with Owner-Architect and Architect-Consultant agreements.

- C. Provide the BoD documents, prepared by Architect and approved by Owner, to the CxA and [each] Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

### 1.6 [EACH]CONTRACTOR'S RESPONSIBILITIES

Coordinate this Article with requirements specified in Division 01 Section "Summary of Multiple Contracts" for Project Coordinator's responsibilities.

- A. **[Each]** Contractor and their subcontractors shall assign representatives with expertise and authority to act on their behalf and schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
  2. Cooperate with the CxA for resolution of issues recorded in “Issues Log.”
  3. Attend and participate in commissioning team meetings held **[weekly]** **[biweekly]** **[monthly]** **[variable]** **<Insert frequency>**.
  4. Integrate and coordinate commissioning process activities with construction schedule.
  5. Review and accept construction checklists provided by the commissioning authority.
  6. Complete **[paper]** **[electronic]** construction checklists as Work is completed and provide to the commissioning authority on a **[daily]** **[weekly]**, **<Insert frequency>**, basis.
  7. Review and accept commissioning process test procedures provided by the commissioning authority.
  8. Accomplish commissioning process test procedures.

#### 1.7 CxA'S RESPONSIBILITIES

Include CxA responsibilities in this Article that have impact on Contractor activities and responsibilities.

- A. Organize and lead the commissioning team.
- B. Provide commissioning plan.
- C. Convene commissioning team meetings.
- D. Provide Project-specific construction checklists and commissioning process test procedures.
- E. Verify the execution of commissioning process activities using random sampling. The sampling rate may vary from 1 to 100 percent. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, CxA will report the failure in the “Issues Log.”

- F. Prepare and maintain issues log.
- G. Prepare and maintain completed construction checklist log.
- H. Witness systems, assemblies, equipment, and component startup.
- I. Compile test data, inspection reports, and certificates and include them in the systems manual and commissioning process report.

#### PART 2 – PRODUCTS (NOT USED)

#### PART 3 – EXECUTION (NOT USED)

#### END OF SECTION 01 9113

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**(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)**

### INFORMATIVE ANNEX M CONSTRUCTION CHECKLISTS

*This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.*

#### OVERVIEW

Construction Checklists consist of two types:

**Component/Equipment Based:** These Construction Checklists are utilized for components and pieces of equipment that are delivered, installed, and started up during construction. There is an individual checklist for each individual component or piece of equipment.

**System/Assembly Based:** These Construction Checklists are utilized for systems and assemblies where separate checklists cannot be applied to subcomponents of the system or assembly. There is a single checklist for the entire system.

The following provides a generic structure to follow for the development of Construction Checklists for any equipment, component, system, or assembly.

## **[INSERT EQUIPMENT/COMPONENT NAME] CHECKLIST**

**TAG ID:** \_\_\_\_\_

### **GENERAL INSTRUCTIONS:**

1. This form is to be completed as the work is completed on [insert equipment/component name].
2. Complete Section 1 – Model verification upon delivery of equipment/component to either the job site or storage location.
3. Complete Section 2 – Pre-installation checks just prior to initial installation.
4. Complete Section 3 – Installation as installation progresses.
5. Fill in data, circle item, and initial as indicated.

### **1. [INSERT EQUIPMENT/COMPONENT NAME] MODEL VERIFICATION**

	<b>Specified</b>	<b>Submitted</b>	<b>Installed</b>
[list items to check, such as make, model, and size]			

### **2. PRE-INSTALLATION CHECKS**

The following must be completed upon delivery of equipment/component to the work site.

		<b>Contractor</b>	<b>Initial</b>	<b>CxA</b>
<b>2A</b>	<b>Physical Checks</b>			
	[insert physical checks to be verified prior to installation, such as “free of damage” and cleanliness]	Yes / No		
		Yes / No		
		Yes / No		
		Yes / No		
<b>2B</b>	<b>Component Verification</b>			
	[insert component checks to be verified prior to installation, such as location and type of components]	Yes / No		
		Yes / No		
		Yes / No		
		Yes / No		

### 3. INSTALLATION

The following items need to be verified during installation. Fill in blanks with check, specific information, or circle “yes” or “no.” For any negative responses, complete Section 4.

		Contractor	Initials	CxA
3A	[insert title of major installation step]			
	[insert items to verify as installation step is accomplished]	Yes / No		
		Yes / No		
		Yes / No		
		Yes / No		
3B	[insert title of major installation step]			
	[insert items to verify as installation step is accomplished]	Yes / No		
		Yes / No		
		Yes / No		
		Yes / No		
3C	[insert title of major installation step]			
	[insert items to verify as installation step is accomplished]	Yes / No		
		Yes / No		
		Yes / No		
		Yes / No		
3D	[insert title of major installation step]			
	[insert items to verify as installation step is accomplished]	Yes / No		
		Yes / No		
		Yes / No		
		Yes / No		
3E	[insert title of major installation step]			
	[insert items to verify as installation step is accomplished]	Yes / No		
		Yes / No		
		Yes / No		
		Yes / No		

### 4. NEGATIVE RESPONSES (ATTACH SHEETS AS NECESSARY)

Item	Reason for negative response	Resolution

## **[INSERT SYSTEM/ASSEMBLY NAME] INSTALLATION CHECKLIST**

### **GENERAL INSTRUCTIONS**

1. This form is to be completed daily by each [insert system/assembly name] work crew at the end of its shift.
2. Date and describe work completed in the appropriate section (1 for pre-installation and 2 for installation).
3. Verify achievement of quality requirements by circling "Yes" or "No." For negative responses, complete Section 3.
4. Initial.

### **1. [INSERT SYSTEM/ASSEMBLY NAME] PRE-INSTALLATION CHECKS**

Date	Description of Work Performed	Items (see descriptions below)					Percent Complete	Initial
		[insert title A]	[insert title B]	[insert title C]	[insert title D]	[insert title E]		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		
		Yes / No	Yes / No	Yes / No	Yes / No	Yes / No		

[INSERT TITLE A]: [INSERT DESCRIPTION OF TITLE A]

[INSERT TITLE B]: [INSERT DESCRIPTION OF TITLE B]

[INSERT TITLE C]: [INSERT DESCRIPTION OF TITLE C]

[INSERT TITLE D]: [INSERT DESCRIPTION OF TITLE D]

[INSERT TITLE E]: [INSERT DESCRIPTION OF TITLE E]

## 2. [INSERT SYSTEM/ASSEMBLY NAME] INSTALLATION CHECKS

[illegible]

[INSERT TITLE F]: [INSERT DESCRIPTION OF TITLE F]

[INSERT TITLE G]: [INSERT DESCRIPTION OF TITLE G]

[INSERT TITLE H]: [INSERT DESCRIPTION OF TITLE H]

[INSERT TITLE I]: [INSERT DESCRIPTION OF TITLE I]

DRAWINGS UPDATED: THE INSTALLED SYSTEM IS SHOWN ON THE RECORD DRAWINGS.

### 3. CONFLICTS (ATTACH SHEETS AS NECESSARY)

Date	Description of Conflict	Suggested Resolution	Resolved?
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No

(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)

## INFORMATIVE ANNEX N QUALITY-BASED SAMPLING EXAMPLES

*This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.*

### DESIGN PHASE SUBMISSIONS

A critical step in the Commissioning Process is the review of the design submissions from the design professionals. It is important to remember that the role of the Commissioning Authority is to verify that the Owner's Project Requirements are met and that the system is designed in a quality manner. There are three distinct reviews that are completed on a drawing set – general, coordination, and field specific. A review of the specifications is also required. The general steps of completing a drawing review are as follows:

#### GENERAL REVIEW

1. *Review the Owner's Project Requirements:* Since the drawing review is to verify that the Owner's Project Requirements were met, prior to the review, the Owner's Project Requirements should be reviewed to familiarize the reviewer with the key criteria of the facility.
2. *Document the General Review Criteria:* The criteria from which to accomplish the general review of the submission must be documented. The criteria should be based on general quality characteristics and specific Owner's Project Requirements criteria. The general quality characteristics should include items such as:
  - Continuation of items (ductwork, pipes, etc.) from page to page
  - Labeling, including correct room numbering
  - Details corresponding to actual components
  - Schedules including basis of design information
  - All information legible (not hidden by crossing lines or text)
  - Owner's Project Requirements information is included on drawings
3. *Accomplish Quick General Review:* The general review is intended to familiarize the reviewer with the submission. If during this review significant items are identified as of poor quality, then the review process should be stopped and the design professionals contacted to discuss the quality concerns. If the general quality is good, move on to the Coordination Review.

#### COORDINATION REVIEW

1. *Determine Sampling Areas:* For each floor plan area (i.e., if there are five sheets for each floor, then there are five floor plan areas for each floor) select a single 10" by 10" square

randomly. A simple way to do this is to divide the drawing sheet into 15 squares (5 by 3) and select square number 3 on the first sheet (area) and then 5, 7, etc., for each remaining area. This selection is accomplished typically using the architectural sheets.

2. *Select Review Samples on Drawings:* Using the sampling strategy chosen in Step 1, mark the sample areas to be reviewed in each area. This should be accomplished for each trade (landscaping, architectural, structural, plumbing, mechanical, electrical, etc.).
3. *Accomplish Coordination Review:* For each area, compare the squares between each discipline. The intent of this review is to identify coordination problems with the placement and installation of components. Items of specific interest include:
  - Placement of multiple pieces of equipment/components in the same location
  - Accessibility to equipment/components for maintenance/replacement
  - Use of consistent terminology (e.g., room numbers,)
  - Elevations provided where multiple systems are placed in the same area
  - Other trade duties clearly identified (e.g., electric wiring for HVAC equipment, holes for sinks)

If significant coordination problems are identified, stop the review and contact the design professionals to discuss. If the coordination is good, continue on with the Field Specific Review.

#### FIELD SPECIFIC REVIEW

1. *Determine the Review Sampling Procedure:* Use random sampling that selects every  $x^{\text{th}}$  square on the drawings to be verified. Squares that are completely blank (no walls, equipment, etc.) are not included in the counting. For example, if there are 10 pages of drawings and each drawing is split into 15 grids (5 × 3), there will be 150 potential grids to review. If a 20% sample rate is desired, then 30 grids would be reviewed, or every 5 grids. The starting grid should be chosen using a random selection process (die, 1-6 in a hat, etc.).
2. *Document Review Criteria:* The criteria from which to review the drawings should be based on specific Owner's Project Requirements criteria. This typically includes items such as accessibility, maintainability, meeting sustainability goals, comfort conditions, documentation of Owner's Project Requirements and Basis of Design, and operating details.
3. *Select Review Samples on Drawings:* Using the sampling strategy chosen in Step 1, mark the sample areas to be reviewed.
4. *Accomplish Detailed Statistical Review:* Using the review criteria from Step 2 and the selections from Step 3, accomplish a detailed review of the drawings. This includes verifying that the specifications match those shown on the drawings (see below for specification review details). For

example, if a VAV box is in the selected square, the steps in accomplishing the detailed review might include:

- (a) Review design calculation inputs for matching architectural assumptions and the Owner's Project Requirements.
  - (b) Compare calculation results with the total airflow of the diffusers downstream of the VAV box and with the VAV box schedule.
  - (c) Compare location of VAV box with maintenance requirements of the selected make and model (Basis of Design).
  - (d) Compare VAV box location on drawings with requirements in the specifications.
  - (e) Review the Owner's Project Requirements for other issues that the VAV box could impact.
5. *Document Concerns:* During the review of the drawings keep detailed notes of problems found or concerns with certain items. Also, at the end of the review, a general summary of the quality of the drawings should be developed. A letter detailing the quality of the drawings should then be sent to the design professionals and the owner with specific recommendations and directions given.
  6. *Review the Drawing Review Procedure:* After the drawing review is completed, this document should be reviewed and modified to improve the process for the next time.

## SPECIFICATION REVIEW

1. *Determine the Review Sampling Procedure:* The purpose of this review is to determine the general quality of the specifications. During the Field Specific Review the actual details are checked. The sampling procedure should check approximately 10% of the specifications. The easiest way of doing this is to check every  $x^{\text{th}}$  page of the specifications (i.e., if there are 100 pages, check every 10<sup>th</sup> page).
2. *Accomplish General Review:* The review should focus on the quality of the specification, specifically:
  - Are there extraneous sections that do not pertain to the project (i.e., medical gas in an office building, 15 types of valves when only 2 used, etc.)?
  - If a manufacturer has been listed, has the engineer checked to verify that the Owner's Project Requirements are met?
  - Are there any "or as equals"? ("As equal" should always be defined)
  - Are the directions clear and concise?
3. *Develop Summary of Review* – Develop a summary of the review. If there are problems with the specifications, contact the design professionals and discuss.

## DESIGN PROFESSIONAL ACTIONS

Comments provided by the Commissioning Authority need to be formally replied to by the design professionals. If systemic issues are identified during the Commissioning Authority's review, the design process should be stopped and the issues resolved. It is expected at the next submission that the Commissioning Authority will again use random sampling

that will result in a review of different areas on the drawings and the specifications and that will identify whether the systemic issue has been resolved. Back-checking of the specific items may be appropriate, but not as the sole means of verifying resolution of the issue.

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**(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)**

## INFORMATIVE ANNEX O SYSTEMS MANUAL

*This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.*

Developing the Systems Manual encompasses gathering all of the information related to the systems, assemblies, and the Commissioning Process and incorporating it into a usable information resource with indexes and cross-references. This resource shall include the final Owner's Project Requirements, Basis of Design, the final Commissioning Plan, Commissioning Process Report, manufacturer installation manuals, manufacturer operations and maintenance manuals, system schematics, verified Record Drawings, and test results. This information is edited and organized to focus upon the key systems (roofing, walls, fire alarm, chilled water, hot water, etc.) in the building. Coordination with operations and maintenance personnel in developing standard formats and divisions (shops) is accomplished to simplify future Systems Manual development.

Also included in the Systems Manual is the development of periodic maintenance and information for insertion into a computer maintenance management system (CMMS), including equipment make and model information, checking requirements, maintenance requirements, and troubleshooting items.

The Commissioning Authority shall be responsible for verifying the development of the Systems Manual.

The entity responsible for developing the Systems Manual shall include all items involved in the project and capture the system and assembly data in either an electronic or printed version. In addition, printed operations, service, maintenance, spare parts list, and repair manuals may be provided. This entity (owner, contractor, design professional, other) shall have the skills of design, construction, and operations required to develop a cohesive Systems Manual.

The required details for a full Systems Manual are enhanced in each of the technical Commissioning Process Guidelines. The Systems Manual will have multiple sections depending upon the number of systems focused upon during the Commissioning Process. The Systems Manual will include a detailed table of contents with a notation as to resource storage location if not in the actual manual. The following outline is a recommended format:

## 1. General.

### (a) Executive Summary (facility level).

This section includes an overall description of the building and its systems, including a listing of major capabilities and limitations imposed by the design or building code. The description should include type of facility, general description (number of floors, gross area, net area, type of occupancy, etc.), and general system descriptions. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information should be included in this section.

### (b) Owner's Project Requirements (facility level).

A copy of the final Owner's Project Requirements for the facility is included in this section. This document was initially developed during the Pre-Design Phase and was updated throughout the project by the Owner, Commissioning Authority, or design professionals.

### (c) Basis of Design (facility level).

This section includes the final Basis of Design document at a facility level. This document is written by the design professionals during the Design Phase and is updated by them to include any changes during the Construction Phase.

### (d) Construction Record documents and specifications (not included in specific systems sections).

This section includes elements of the record set of Construction Documents (including specifications) that are not covered under specific systems—updated to reflect the final installation.

### (e) Approved submittals (not included in specific system sections).

This section includes a copy of the approved submittals (not included under specific systems) with all field modifications and accessories clearly marked. In addition, the comments from original submittals shall be included.

### (f) Facility operating procedures for all normal, abnormal, and emergency modes of operation (facility level).

This section includes detailed operating procedures for the facility during normal, abnormal, and emergency modes of operation. This is not intended to be automatic control sequences, but general operating procedures. This would include items such as building access during various situations (normal operation, after-hours operation, fire alarm, civil disturbance operation, emergency power operations, etc.).

### (g) A list of recommended operational record keeping procedures at the facility level, including sample forms, trend logs, or others, and a rationale for each.

This section includes direction to the operation and maintenance personnel as to what information needs to be

documented and kept on the operation of the facility and why these records are important or will benefit the Owner or operations and maintenance personnel in the future.

### (h) Maintenance procedures, schedules, and recommendations (facility level).

This section includes the manufacturer's recommendations for maintenance procedures and when maintenance should be performed on systems not included in specific system sections.

### (i) Ongoing Optimization (facility level).

This section includes guidance for the ongoing optimization of the facility. Included in the section are schedules of periodic benchmarking using checklists and tests developed for the original construction, procedures for maintaining the Owner's Project Requirements and Basis of Design documents, and guidance on what to do when the Owner's Project Requirements are not achieved.

### (j) Attachments:

Commissioning documents listing and storage location.

*[The following section is completed for each system or assembly requiring operation and maintenance.]*

## 2. xxx System/Assembly.

### (a) Executive Summary (xxx System/Assembly).

This section includes a description of the systems/assemblies covered in this section, including a listing of capabilities and limitations imposed by the design or building code. The description should include type of system/assembly, general description, and schematics. A list of contractors, subcontractors, suppliers, and design professionals involved with this system along with their contact information should be included.

### (b) Owner's Project Requirements (xxx System/Assembly level).

A copy of the final Owner's Project Requirements dealing with this system/assembly is included in this section. This document was initially developed during the Pre-Design Phase and was updated throughout the project by the Owner, Commissioning Authority, or design professionals.

### (c) Basis of Design (xxx System/Assembly level).

This section includes the final Basis of Design document (including the design intent) as related to the specific systems included in this section. This document is typically written by the design professionals during the Design Phase and is updated by them to include any changes during the Construction Phase.

### (d) Construction Record documents and specifications (xxx System/Assembly).

This section includes the record set of Construction Documents (including specifications) that has been updated to reflect the final installation of the specific system/assembly included in this section.

- (e) Approved submittals (xxx System/Assembly).

This section includes a copy of the approved submittals for the components associated with the system/assembly with all field modifications and accessories clearly marked. In addition, the comments from original submittals shall be included.

- (f) Operating procedures for all normal, abnormal, and emergency modes of operation (xxx System/Assembly).

This section includes detailed operating procedures for xxx systems/assemblies during normal, abnormal, and emergency modes of operation. This is not intended to be automatic control sequences, but general operating procedures.

- (g) A list of recommended operational record-keeping procedures, including sample forms, trend logs, or others, and a rationale for each (xxx System/Assembly).

This section includes direction to the operations and maintenance personnel as to what information needs to be documented and kept on the operation of the systems and why these records are important or will benefit the Owner or operations and maintenance personnel in the future.

- (h) Maintenance procedures, schedules, and recommendations (xxx System/Assembly).

This section includes the manufacturer's recommendations for maintenance procedures and when maintenance should be performed.

- (i) Ongoing optimization (xxx System/Assembly).

This section includes guidance for the ongoing optimization of the system/assembly. Included in the section are schedules of periodic benchmarking using checklists and tests developed for the original construction, procedures for maintaining the Owner's Project Requirements and Basis of Design documents, and guidance on what to do when the Owner's Project Requirements are not achieved.

- (j) Operations and maintenance manuals (xxx System/Assembly).

This section includes the manufacturer's printed operations and maintenance manuals for the specific equipment/components provided for the xxx system/assembly. Also included is a parts and recommended spare parts list, a troubleshooting guide for common situations, and one-line diagrams for each applicable system.

- (k) Training records (xxx System/Assembly).

This section includes information on training provided and attendees. In addition, information on ongoing training shall be provided.

- (l) Commissioning Process Report for xxx System/Assembly.

This section includes the Final Commissioning Process Report for the xxx system/assembly, including all test procedures, test results, and blank test forms.

**(This annex is not part of this guideline. It is merely informative and does not contain requirements necessary for conformance to the guideline.)**

## **INFORMATIVE ANNEX P TRAINING MANUAL AND TRAINING NEEDS**

*This annex provides an example of how to implement part of Guideline 0. It is not intended to be a comprehensive representation or a best practice example. Practitioners applying the Commissioning Process should carefully follow Guideline 0 and applicable commissioning technical guidelines tailored to their specific projects.*

This annex is a collection of various requirements for training and identifies needs for the Training Manual. The Training Manual includes the Training Plan, which is composed of the Training Syllabus and Training Agenda that are provided to the contractor by the Owner with help from the CxA. The Training Manual also contains the results of training, including the Training Material and Training Evaluations completed by the Contractor. It is an example to provide direction, in that training needs vary substantially for each construction project or new building. The following is an example of a Training Manual outline or syllabus for the Training Manual with a focus on electrical and mechanical systems.

### **TRAINING SYLLABUS**

#### **Overview**

This syllabus describes the objectives of the various sessions, lectures, and demonstrations that form a part of the training program developed for the Do-It-Right Building.

#### **Sessions**

There are two main sessions on the electrical systems and two main sessions on the mechanical systems that will provide training to the OK Service personnel. The first session will be conducted at the time of start-up and check-out and the second session will be about two months later. Sessions will be a minimum of two days duration for the basics in each system and be conducted as specified below. The sessions will be conducted at the site.

All training sessions will be visually recorded using either videotape (VHS format) or standard compact disk (CD) in PC format. The CD format is desired for longevity and keyword searching. The sessions can be recorded on videotape and then transferred to CDs.

A training agenda in the format enclosed will be provided for each session. This will be submitted three weeks prior to the scheduled training session. All listed owner's representatives will sign this prior to proceeding with the training.

A list of training topics that are appropriate for consideration are listed in the attached Training Agenda Topics list.

The Commissioning Authority will be notified of the scheduled training time and provided with a copy of the training material fifteen days prior to each training session. The Commissioning Authority will review the material and share

comments with the Owner and the design professionals. If any aspects do not meet the requirements of the specifications, this will be communicated through the design professionals. The Commissioning Authority will attend 25% or more of the training sessions.

A receipt acknowledging completion of each item of instruction will be secured.

The training will be evaluated based upon the criteria in the attached evaluation form.

## Electrical Systems

The training shall include:

- General familiarization and operating procedures for the entire electrical installation.
- Routine maintenance procedures for equipment.
- Specific operating and maintenance procedures for:
  - Switchboards
  - Emergency power supply system
  - Fire alarm system

Factory-trained technicians will provide operating and maintenance instructions on the following:

System/Equipment	Minimum Session Duration, hours
Emergency power supply system	x
Fire alarm system	x
Lighting control systems	x
Switchboards	x
Medium voltage pad-mounted switchgear	x

## Mechanical Systems

The training shall include:

- General familiarization with and operating procedures for the entire plumbing, laboratory gas, pure water, compressed air, fuel, HVAC&R, and fire protection systems installation.
- Routine maintenance procedures for equipment.
- Specific operating and maintenance procedures for:
  - Hot water system consisting of boilers, pumps, controls, and hydronic specialties.

- Chilled water systems consisting of chillers, cooling towers, pumps, controls, and hydronic specialties.
- Automatic temperature control system consisting of all associated hardware, software, and program logic; this is to be arranged by systems.
- Laboratory air-side control system consisting of supply, hood, and general exhaust valves, reheat coils, and room control panel.
- Clean agent fire suppression systems, including emergency procedures, abort functions, and safety requirements.
- Laboratory hood exhaust air system.

Factory-trained technicians will give instruction on the following specialty systems and equipment:

System/Equipment	Minimum Session Duration, hours
Variable speed drives	x
Chillers	x
Automatic temperature controls	x
Water treatment systems	x
Laboratory control systems	x

## DDC System

There will be two formal training sessions on the DDC system. Each of the sessions will be conducted by factory-trained personnel for a minimum duration of xx 8-hour days. Materials and training will be provided for up to xx operators per session (selected by the Owner).

There will be a separate training course provided on the DDC system for supervisory personnel. This training will briefly cover the material of the operator training session but will be focused on the more advanced features of the system with emphasis on the energy conservation strategies and reporting capabilities of the system and how to implement them. The training session will be conducted by factory-trained personnel for a minimum duration of xx 8-hour days, for a total of xx training hours. Materials and training will be provided for up to xx persons selected by the Owner.

## TRAINING AGENDA

<b>Project:</b>	Do-It-Right—Wonderful Sky Building
<b>Training Material:</b>	Systems Manual; Evaluation Forms; Record Forms; Specification Sections, Miscellaneous Manufacturer's Documentation, Field Equipment (for demonstrations)

### SECTION 1. AUDIENCE AND GENERAL SCOPE

Intended audience type: ☒ O&M Staff, ☒ Supervisory Personnel  
☒ Laboratory Users ☒ \_\_\_\_\_  
General scope of training: ☐ A. Overview ☒ B. Intermediate ☒ C. Detailed

### SECTION 2. INSTRUCTORS

ID	Instructor (Factory Trained)	Company
1)	_____	_____
2)	_____	_____
3)	_____	_____
4)	_____	_____
5)	_____	_____

### SECTION 3. AGENDA

#### SESSION A – ELECTRICAL AND FIRE PROTECTION SYSTEMS

	Lectures/Demonstrations	Dates	Location	Duration (hr x freq*)	Instructor ID(s)
A1	Emergency power supply system	_____	_____	8 x 2	_____
A2	Fire alarm system	_____	_____	8 x 2	_____
A3	Lighting control	_____	_____	4 x 2	_____
A4	Switchboards	_____	_____	4 x 2	_____
A5	Medium voltage pad-mounted switchgear	_____	_____	4 x 2	_____
A6	O&M procedures for clean agent fire suppression systems, including emergency procedures, abort functions, and safety requirements	_____	_____	4 x 2	_____

Total duration of training (h) ----->

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#### SESSION B – MECHANICAL AND PLUMBING SYSTEMS

	Lectures/Demonstrations	Dates	Location	Duration (hr x freq*)	Instructor ID(s)
B1	Variable speed drives	_____	_____	4 x 2	_____
B2	Chillers	_____	_____	4 x 2	_____
B3	General familiarization and operating procedures for plumbing equipment	_____	_____	3 x 2	_____
B4	Water treatment systems	_____	_____	2 x 2	_____

Total duration of training (h) ----->

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## SESSION C – CONTROL SYSTEM

Lectures/Demonstrations	Dates	Location	Duration (hr x freq)	Instructor ID(s)
C1 Laboratory control systems	_____	_____	8 × 2*	_____
C2 Automatic temperature controls	_____	_____	10 × 2*	_____
C3 DDC system operations (for up to xx operators)	_____	_____	32 × 2*	_____
C4 DDC system emphasis on advanced features of system, energy conservation strategies, and reporting capabilities and how to implement them (for up to xx supervisors)	_____	_____	16 × 1	_____

Total duration of training (h) ----->

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\* Frequency is 2 formal training sessions as per spec. sections 15900, pg. 16, Part 2.1, and 16800, pg. 5, Part 7.3. The first session shall be conducted at the time of start-up and check-out and the second session shall be approximately 2 months later.

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## SECTION 4. APPROVALS

This Training Program has been approved by the following individuals, subject to any additions and clarifications noted.  
(This is not an approval of training completion.)

\_\_\_\_\_  
Do-It-Right, Inc. Representative

\_\_\_\_\_  
Date

\_\_\_\_\_  
Commissioning Authority

\_\_\_\_\_  
Date

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## TRAINING AGENDA TOPICS

(Suggested General Topics to Be Included)

Suggested List of Subjects		Requested by D-I-R, Inc. (✓)	Desired Duration (h)
1.	Overview and description of the purposes of the system		
2.	System troubleshooting: description of diagnostic step-by-step procedures for determining the source of problems on the system level; review technical service manual in detail		
3.	Component maintenance: instruction of required procedures for weekly, monthly, and annual preventive checks and timely repairs to preserve system integrity		
4.	Component troubleshooting: description of diagnostic procedures for determining the source of problems on the component level		
5.	Review of control drawings and schematics (have copies for attendees)		
6.	Startup, loading, normal operation, unloading, shutdown, unoccupied operation, seasonal changeover, etc., as applicable		
7.	Integral controls (packaged): programming, troubleshooting, alarms, manual operation		
8.	Building automation system (BAS) controls: programming, troubleshooting, alarms, manual operation, interface with integral controls		
9.	Interactions with other systems, operation during power outage and fire		
10.	Relevant health and safety issues and concerns and special safety features		
11.	Energy-conserving operation and strategies		
12.	Any special issues to maintain warranty		
13.	Common troubleshooting issues and methods, control system warnings and error messages, including using the control system for diagnostics		
14.	Special requirements of tenants for this equipment's function		
15.	Service, maintenance, and preventive maintenance (sources, spare parts inventory, special tools, etc.)		
16.	Question and Answer Period		
Total hours requested			
Total hours required by specifications			

## Training Evaluation

Session: \_\_\_\_\_

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

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

**Purpose:** This form is used to evaluate each training session. Based upon this evaluation, later sessions can be improved. This form will be completed by the Commissioning Authority and one D-I-R employee in the training session after each session.

*Every attendee fills out one copy of this form. Mark questions that are not applicable with N/A.*

1 = very well to 5 = not at all						
1. How were the objectives of this training session met?	1	2	3	4	5	N/A
2. Do you know where the components/systems are located?	1	2	3	4	5	N/A
3. Do you know what area the components/systems are serving?	1	2	3	4	5	N/A
4. Do you understand the various types and purpose of these components/systems?	1	2	3	4	5	N/A
5. Do you understand/know how to systematically troubleshoot common problems with these components/systems?	1	2	3	4	5	N/A
6. Do you know how the components/systems operate under all normal modes?	1	2	3	4	5	N/A
7. How well do you understand the importance of meeting the design intent for the systems covered?	1	2	3	4	5	N/A
8. Are you able to efficiently find the relevant information in the Systems Manual to operate and maintain the systems/components you were trained for in this session?	1	2	3	4	5	N/A
9. Do you know how to perform the needed maintenance on the equipment and/or do you know to get the information you need?	1	2	3	4	5	N/A
10. Do you know how to get updated technical service information for the components/systems?	1	2	3	4	5	N/A

Explain why any questions got very low or very high ratings from you:

What topics would you desire to be covered that were absent from this training session?

You may provide other comments concerning anything about this training session (e.g., information prior to training, content):



## **POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES**

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the standards and guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive technical committee structure, continue to generate up-to-date standards and guidelines where appropriate and adopt, recommend, and promote those new and revised standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating standards and guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.



## SECTION 024119 - SELECTIVE DEMOLITION

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 017300 "Execution" for cutting and patching procedures.
3. Section 070150.19 "Preparation for Reroofing" for impacted areas of the roofing membrane.

#### 1.2 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and store.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

#### 1.3 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

#### 1.4 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at Sato Elementary School
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 is to remain and requires protection.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Engineering Survey: Submit engineering survey of condition of building.
- B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
- C. Schedule of Selective Demolition Activities: Indicate the following:
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. Coordination of Owner's continuing occupancy of portions of existing building.
- D. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by salvage and demolition operations. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

#### 1.7 FIELD CONDITIONS

- A. Owner may occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

1. Before selective demolition, Owner will remove the following items:
    - a. Classrooms, library, and computer lab will be emptied of all loose furnishings, furniture, and equipment prior to Contractor mobilization.
  - C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
  - D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
    1. 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.
- 1.8 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 before proceeding. Existing warranties include the following:
    1. TPO Roofing Membrane
  - B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.
- 1.9 COORDINATION
- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

## SELECTIVE DEMOLITION

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## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any 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. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
- E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

### 3.2 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

### 3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them 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 areas to be selectively demolished.
  - 1. Arrange to shut off utilities with utility companies.
  - 2. 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.
  - 3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.

## SELECTIVE DEMOLITION

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- 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 and Salvaged: 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.

### 3.4 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
  2. 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.
  3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
  4. Cover and protect furniture, furnishings, and equipment that have not been removed.
- B. Temporary Shoring: 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.
  1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

### 3.5 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. 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 2 hours after flame-cutting operations.
  6. Maintain adequate ventilation when using cutting torches.
  7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
  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 so as not to impose excessive loads on supporting walls, floors, or framing.
  10. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."
- B. 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.
- C. Removed and Salvaged Items:
1. Clean salvaged items.
  2. Pack or crate items after cleaning. Identify contents of containers.
  3. Store items in a secure area until delivery to Owner.
  4. Transport items to Owner's storage area as designated by Owner.
  5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
  2. Pack or crate items after cleaning and repairing. Identify contents of containers.
  3. Protect items from damage during transport and storage.
  4. 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.

### 3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. 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.
- B. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.
- C. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight. New roofing materials to match roofing materials on existing building.

### 3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
  - 1. Do not allow demolished materials to accumulate on-site.
  - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
  - 4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- B. Burning: Do not burn demolished materials.

### 3.8 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 024119

## SECTION 033000 - CAST-IN-PLACE CONCRETE

### 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. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

#### B. Related Requirements:

- 1. Division 32 for concrete pavement and walks.
- 2. Section 072600 "Vapor Retarders."
- 3. Section 079200 "Joint Sealants."

### 1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

- 1. 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.
  - e. Special concrete finish Subcontractor.
- 2. Review the following:

- a. Special inspection and testing and inspecting agency procedures for field quality control.
- b. Construction joints, control joints, isolation joints, and joint-filler strips.
- c. Semirigid joint fillers.
- d. Vapor-retarder installation.
- e. Anchor rod and anchorage device installation tolerances.
- f. Cold and hot weather concreting procedures.
- g. Concrete finishes and finishing.
- h. Curing procedures.
- i. Forms and form-removal limitations.
- j. Shoring and reshoring procedures.
- k. Methods for achieving specified floor and slab flatness and levelness.
- l. Floor and slab flatness and levelness measurements.
- m. Concrete repair procedures.
- n. Concrete protection.
- o. Initial curing and field curing of field test cylinders (ASTM C31/C31M.)
- p. Protection of field cured field test cylinders.

## 1.5 ACTION SUBMITTALS

### A. Product Data: For each of the following.

1. Portland cement.
2. Fly ash.
3. Aggregates.
4. Admixtures:
  - a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
5. Color pigments.
6. Fiber reinforcement.
7. Vapor retarders.
8. Floor and slab treatments.
9. Liquid floor treatments.
10. Curing materials.
  - a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.
11. Joint fillers.
12. Repair materials.

### B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Calculated equilibrium unit weight
6. Slump limit.
7. Air content.
8. Nominal maximum aggregate size.
9. Synthetic micro-fiber content.
10. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
11. Intended placement method.
12. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
  - a. Location of construction joints is subject to approval of the Architect.

D. Samples: For vapor retarder.

E. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

## 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.
3. Testing agency: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.

3. Curing compounds.
4. Floor and slab treatments.
5. Bonding agents.
6. Adhesives.
7. Vapor retarders.
8. Semirigid joint filler.
9. Joint-filler strips.
10. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Portland cement.
2. Fly ash.
3. Aggregates.
4. Admixtures:
  - a. Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

E. Research Reports:

1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
2. For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.

F. Preconstruction Test Reports: For each mix design.

G. Field quality-control reports.

H. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician.

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

- C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.
  - 1. Personnel performing laboratory tests shall be an 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. Field Quality Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
  - 1. Personnel conducting field tests shall be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

#### 1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.
  - 1. Include the following information in each test report:
    - a. Admixture dosage rates.
    - b. Slump.
    - c. Air content.
    - d. Seven-day compressive strength.
    - e. 28-day compressive strength.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with ASTM C94/C94M and ACI 301 (ACI 301M).

#### 1.10 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 301 (ACI 301M) and ACI 306.1 and as follows.
  - 1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - 2. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301 (ACI 301M).
  - 3. Do not use frozen materials or materials containing ice or snow.

4. Do not place concrete in contact with surfaces less than 35 deg F (1.7 deg C), other than reinforcing steel.
  5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and ACI 305.1 (ACI 305.1M), and as follows:
1. Maintain concrete temperature at time of discharge to not exceed 95 deg F (35 deg C).
  2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

#### 1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.
1. Warranty Period: 10 years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301 (ACI 301M).
  2. Concrete finishing at all exposed concrete floors shall comply with standards for OSHA and ADA non-slip requirements.

#### 2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that 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.
- B. Form Liners: Units of face design, texture, arrangement, and configuration to match those used for precast concrete sandwich panels on existing school. Use with manufacturer's recommended form-release agent that does not bond with, stain, or adversely affect cast-in-place concrete surfaces and does not impair subsequent surface or joint treatments of cast-in-place concrete.

### CAST-IN-PLACE CONCRETE

033000 - 6

1. Form liners basis of design: Fitzgerald GrayLastic Pattern 16938 Random Plank.
  2. Form liner must match existing school façade.
- C. 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.
- D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.
- E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does 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 glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
  2. Furnish ties that, when removed, leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
  3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

## 2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.

## 2.4 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, cut 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.

## 2.5 CONCRETE MATERIALS

### A. Source Limitations:

1. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
2. Obtain aggregate from single source.
3. Obtain each type of admixture from single source from single manufacturer.

### B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I or Type II
2. Fly Ash: ASTM C618, Class C or F.

### C. Normal-Weight Aggregates: ASTM C33/C33M, coarse aggregate or better, graded. Provide aggregates from a single source.

1. Alkali-Silica Reaction: Comply with one of the following:
  - a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
  - b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
  - c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. (2.37 kg/cu. m) for moderately reactive aggregate or 3 lb./cu. yd. (1.78 kg/cu. m) for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301 (ACI 301M).
2. Maximum Coarse-Aggregate Size: 1-inch or 1-1/2 inches (38 mm) nominal.
3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

### D. Air-Entraining Admixture: ASTM C260/C260M.

### E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.

6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
7. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494/C494M, Type C.
8. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

F. Water and Water Used to Make Ice: ASTM C94/C94M, potable.

G. Color Admixture: Occurs at exterior wall finish only, not at flooring. Color BASF - Black at 7.34 #/cy to match existing vertical textured concrete. Field verify color sample submittal to match existing.

## 2.6 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

1. Color:

- a. Ambient Temperature Below 50 deg F (10 deg C): Black.
- b. Ambient Temperature between 50 deg F (10 deg C) and 85 deg F (29 deg C): Any color.
- c. Ambient Temperature Above 85 deg F (29 deg C): White.

D. Water: Potable or complying with ASTM C1602/C1602M.

E. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

## 2.7 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 in accordance with ASTM D2240.

- C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
  - 1. Types IV and V, load bearing for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Floor Slab Protective Covering: Eight-feet- (2438-mm-) wide cellulose fabric.
- F. Exterior expansion joints adjacent to vertical surfaces
  - 1. Approved Product (or equal): Polyblend Sanded Grout, color to match concrete

## 2.8 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3 mm) and that can be feathered at edges to match adjacent floor elevations.
  - 1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
  - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3 to 6 mm) or coarse sand, as recommended by underlayment manufacturer.
  - 4. Compressive Strength: Not less than 5,000 psi (34.5 MPa) at 28 days when tested in accordance with ASTM C109/C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6 mm) and that can be filled in over a scarified surface to match adjacent floor elevations.
  - 1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
  - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
  - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
  - 4. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested in accordance with ASTM C109/C109M.

## 2.9 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301 (ACI 301M).
  - 1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
  - 1. Fly Ash or Other Pozzolans: 25 percent by mass.
- C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
  - 1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.

## 2.10 CONCRETE MIXTURES

- A. Class A: Normal-weight concrete used for footings and foundation walls
  - 1. Exposure Class: ACI 318 (ACI 318M) F1
  - 2. Minimum Compressive Strength: 4500 psi (31 MPa) at 28 days.
  - 3. Maximum w/cm: 0.45
  - 4. Slump Limit: 8 inches (200 mm), plus or minus 1 inch (25 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture at Project site
  - 5. Air Content:
    - a. Exposure Class F1: 4.5 percent, plus or minus 1.5 percent, at point of delivery for concrete containing 1-inch (25-mm) or 1-1/2-inch (38-mm) nominal maximum aggregate size
  - 6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- B. Class B: Normal-weight concrete used for interior slabs-on-ground.
  - 1. Exposure Class: ACI 318 (ACI 318M) F0
  - 2. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
  - 3. Maximum w/cm: 0.50
  - 4. Minimum Cementitious Materials Content: Comply with ACI 30. 470 lb/cu. yd. (279 kg/cu. m)] for 1 1/2-inch maximum aggregate. 520 lb/cu. yd. (309 kg/cu. m) for 1-inch aggregate.

5. Slump Limit: 8 inches (200 mm), plus or minus 1 inch (25 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture at Project site.
6. Air Content:
  - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
7. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

C. Class C: Normal-weight concrete used for exterior slabs-on-ground.

1. Exposure Class: ACI 318 (ACI 318M) F2
2. Minimum Compressive Strength: 4500 psi (31 MPa) at 28 days.
3. Maximum w/cm: 0.45
4. Slump Limit: 8 inches (200 mm), plus or minus 1 inch (25 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture at Project site
5. Air Content:
  - a. Exposure Class F2: 6.0 percent, plus or minus 1.5 percent, at point of delivery for concrete containing 1-inch (25-mm) nominal maximum aggregate size. 5.5 percent, plus or minus 1.5 percent, at point of delivery for concrete containing 1-1/2-inch (38-mm) nominal maximum aggregate size
6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

2.11 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and furnish batch ticket information.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions:
  1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
  2. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:
  - 1. Access to the Work.
  - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
  - 3. Secure facilities for storage, initial curing, and field curing of test samples, including continuous electrical power.
  - 4. Security and protection for samples and for testing and inspection equipment at Project site.

### 3.3 INSTALLATION OF 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.
  - 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
  - 3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

### 3.4 JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
  - 1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
  - 2. Place joints perpendicular to main reinforcement.
    - a. Continue reinforcement across construction joints unless otherwise indicated.
  - 3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
  - 4. Space vertical joints in walls as indicated on Drawings. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
  - 5. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

- C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.
- D. Isolation Joints in Slabs-on-Ground: 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 on Drawings.
  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 Section 079200 "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:
1. Install dowel bars and support assemblies at joints where indicated on Drawings.
  2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.
- F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.
- G. Fill all joints with sealant as specified in Section 079200 "Joint Sealants" at locations indicated on drawings.

### 3.5 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
  2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.
- B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M), but not to exceed the amount indicated on the concrete delivery ticket.
  - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
  - 1. If a section cannot be placed continuously, provide construction joints as indicated.
  - 2. Deposit concrete to avoid segregation.
  - 3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
  - 4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301 (ACI 301M).
    - a. Do not use vibrators to transport concrete inside forms.
    - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer.
    - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
    - d. 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.
- E. 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. Do not place concrete floors and slabs in a checkerboard sequence.
  - 2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  - 3. Maintain reinforcement in position on chairs during concrete placement.
  - 4. Screed slab surfaces with a straightedge and strike off to correct elevations.
  - 5. Level concrete, cut high areas, and fill low areas.
  - 6. Slope surfaces uniformly to drains where required.
  - 7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
  - 8. Do not further disturb slab surfaces before starting finishing operations.

### 3.6 FINISHING FORMED SURFACES

- A. As-Cast Surface Finishes:
  - 1. ACI 301 (ACI 301M) Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.

- a. Patch voids larger than 1-1/2 inches (38 mm) wide or 1/2 inch (13 mm) deep.
    - b. Remove projections larger than 1 inch (25 mm).
    - c. Tie holes do not require patching.
    - d. Surface Tolerance: ACI 117 (ACI 117M) Class D.
    - e. Apply to concrete surfaces not exposed to public view
  2. ACI 301 (ACI 301M) Surface Finish SF-3.0:
    - a. Patch voids larger than 3/4 inch (19 mm) wide or 1/2 inch (13 mm) deep.
    - b. Remove projections larger than 1/8 inch (3 mm).
    - c. Patch tie holes.
    - d. Surface Tolerance: ACI 117 (ACI 117M) Class A.
    - e. Locations: Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.
- B. Rubbed Finish: Apply the following to as cast surface finishes where indicated on Drawings:
1. Smooth-Rubbed Finish:
    - a. Perform no later than one day after form removal.
    - b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
    - c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
  2. Grout-Cleaned Rubbed Finish:
    - a. Clean concrete surfaces after contiguous surfaces are completed and accessible.
    - b. Do not clean concrete surfaces as Work progresses.
    - c. Mix 1 part portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
    - d. Wet concrete surfaces.
    - e. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap, and keep surface damp by fog spray for at least 36 hours.
  3. Cork-Floated Finish:
    - a. Mix 1 part portland cement to 1 part fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint.
    - b. Mix 1 part portland cement and 1 part fine sand with sufficient water to produce a mixture of stiff grout. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
    - c. Wet concrete surfaces.

- d. Compress grout into voids by grinding surface.
  - e. In a swirling motion, finish surface with a cork float.
- C. Abrasive-Blast Finish: Apply the following to as-cast surface finishes where indicated on Drawings:
  - 1. Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi (13.8 MPa).
  - 2. Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at the same age.
  - 3. Surface Continuity:
    - a. Perform abrasive-blast finishing as continuous operation, maintaining continuity of finish on each surface or area of Work.
    - b. Maintain required patterns or variances in depths of blast to match field samples.
  - 4. Abrasive Blasting:
    - a. Abrasive-blast corners and edges of patterns carefully, using backup boards to maintain uniform corner and edge lines.
    - b. Determine type of nozzle pressure and blasting techniques required to match field sample.
    - c. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match field sample, as follows:
      - 1) Medium Texture: Generally, expose coarse aggregate with slight reveal and with a maximum reveal of 1/4 inch (6 mm).
- D. Related Unformed Surfaces:
  - 1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
  - 2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

### 3.7 FINISHING FLOORS AND SLABS

- A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish:
  - 1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.

2. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 (ACI A117M) tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish.

C. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighen until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface.
5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155 (ASTM E1155M), for a randomly trafficked floor surface:

a. Slabs on Ground:

- 1) Specified overall values of flatness,  $F_F$  35; and of levelness,  $F_L$  25; with minimum local values of flatness,  $F_F$  24; and of levelness,  $F_L$  17.
8. Finish and measure surface, so gap at any point between concrete surface and an unlevelled, freestanding, 10-ft.- (3.05-m-) long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch (3 mm).

D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.

1. Coordinate required final finish with Architect before application.
2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish with Architect before application.

### 3.8 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

#### A. Filling In:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
3. 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:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 4 inches (100 mm) high unless otherwise indicated on Drawings, and extend base not less than 6 inches (150 mm) in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4500 psi (31 MPa) at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.
  - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - b. Cast anchor-bolt insert into bases.
  - c. Install anchor bolts to elevations required for proper attachment to supported equipment.

#### D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.

1. Cast-in inserts and accessories, as shown on Drawings.
2. Screed, tamp, and trowel finish concrete surfaces.

### 3.9 CONCRETE CURING

#### A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 (ACI 301M) and ACI 306.1 for cold weather protection during curing.
2. Comply with ACI 301 (ACI 301M) and ACI 305.1 (ACI 305.1M) for hot-weather protection during curing.

- 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 (1 kg/sq. m x h) before and during finishing operations. Apply in accordance with manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Curing Formed Surfaces: Comply with ACI 308.1 (ACI 308.1M) as follows:
1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
  2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
  3. If forms remain during curing period, moist cure after loosening forms.
  4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
    - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
    - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
    - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
    - d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
    - e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
      - 1) Recoat areas subject to heavy rainfall within three hours after initial application.
      - 2) Maintain continuity of coating and repair damage during curing period.
- D. Curing Unformed Surfaces: Comply with ACI 308.1 (ACI 308.1M) as follows:
1. Begin curing immediately after finishing concrete.
  2. Interior Concrete Floors:
    - a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
      - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
        - a) Lap edges and ends of absorptive cover not less than 12-inches (300-mm).
        - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

- 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 (300 mm), and sealed by waterproof tape or adhesive.
    - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
    - b) Cure for not less than seven days.
  - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
    - a) Water.
    - b) Continuous water-fog spray.
- b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:
- 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
    - a) Lap edges and ends of absorptive cover not less than 12 inches (300 mm).
    - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
  - 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 (300 mm), and sealed by waterproof tape or adhesive.
    - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
    - b) Cure for not less than seven days.
  - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
    - a) Water.
    - b) Continuous water-fog spray.
- c. Floors to Receive Polished Finish: Contractor has option of the following:

- 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
    - a) Lap edges and ends of absorptive cover not less than 12 inches (300 mm).
    - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
  - 2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
    - a) Water.
    - b) Continuous water-fog spray.
- d. Floors to Receive Chemical Stain:
- 1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
  - 2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
  - 3) Butt sides of curing paper tight; do not overlap sides of curing paper.
  - 4) Leave curing paper in place for duration of curing period, but not less than 28 days.
- e. Floors to Receive Urethane Flooring:
- 1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
  - 2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches (150 mm) and sealed in place.
  - 3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
  - 4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.
- f. Floors to Receive Curing Compound:
- 1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
  - 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
  - 3) Maintain continuity of coating, and repair damage during curing period.
  - 4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

g. Floors to Receive Curing and Sealing Compound:

- 1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
- 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
- 3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.10 TOLERANCES

- A. Conform to ACI 117 (ACI 117M).

3.11 APPLICATION OF LIQUID FLOOR TREATMENTS

- A. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

3.12 JOINT FILLING

- A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.
1. 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 joints clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints.
- D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.13 CONCRETE SURFACE REPAIRS

- A. Defective Concrete:
1. Repair and patch defective areas when approved by Architect.
  2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 (1.18-mm) 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 (13 mm) in any dimension to solid concrete.
    - a. Limit cut depth to 3/4 inch (19 mm).
    - b. Make edges of cuts perpendicular to concrete surface.
    - c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
    - d. Fill and compact with patching mortar before bonding agent has dried.
    - e. 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 matches surrounding color.
    - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
    - b. Compact mortar in place and strike off slightly higher than surrounding surface.
  3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces:
1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
    - a. Correct low and high areas.
    - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
  2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  3. After concrete has cured at least 14 days, correct high areas by grinding.
  4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
    - a. Finish repaired areas to blend into adjacent concrete.
  5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
    - a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

- b. Feather edges to match adjacent floor elevations.
- 6. Correct other low areas scheduled to remain exposed with repair topping.
  - a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations.
  - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
- 7. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete.
  - a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around.
  - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
  - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
  - d. Place, compact, and finish to blend with adjacent finished concrete.
  - e. Cure in same manner as adjacent concrete.
- 8. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar.
  - a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
  - b. Dampen cleaned concrete surfaces and apply bonding agent.
  - c. Place patching mortar before bonding agent has dried.
  - d. Compact patching mortar and finish to match adjacent concrete.
  - e. 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.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

### 3.14 SLAB ON GRADE CRACK REPAIR

- A. Repair and seal cracks, holes, and other penetrations in slab-on-grade with sealant as specified in Section 079200 "Joint Sealants".
- B. All cracks in concrete slabs on grade shall be sealed against radon entry as follows:
  - 1. Repair and sealing should occur as late in the construction process as possible.

2. Cracks greater than 1/4-inch wide, all cracks that exhibit vertical displacement, all cracks that connect weakened zones in the slab such as vertical penetrations or reentrant corners, and all cracks that cross changes in materials or planes in the structure shall be enlarged to contain a sealant reservoir not less than 1/2-inch by 1/2-inch in cross-section along the entire length of the crack and shall be sealed with a flexible field-molded elastomeric sealant.
3. Cracks greater than 1/16-inch in width, that do not meet any of the conditions described in Item 2, shall be enlarged to contain a sealant reservoir not less than 1/4-inch by 1/4-inch in cross-section along the entire length of the crack, and shall be sealed with a flexible, field-molded elastomeric sealant.
4. Cracks less than 1/16-inch in width, that do not meet any of the conditions described in Item 2 above may be left unsealed.

### 3.15 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.
- B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
  1. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
  2. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
    - a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
      - 1) Project name.
      - 2) Name of testing agency.
      - 3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
      - 4) Name of concrete manufacturer.
      - 5) Date and time of inspection, sampling, and field testing.
      - 6) Date and time of concrete placement.
      - 7) Location in Work of concrete represented by samples.
      - 8) Date and time sample was obtained.
      - 9) Truck and batch ticket numbers.
      - 10) Design compressive strength at 28 days.
      - 11) Concrete mixture designation, proportions, and materials.
      - 12) Field test results.
      - 13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
      - 14) Type of fracture and compressive break strengths at seven days and 28 days.

- C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.
- D. Inspections:
1. Headed bolts and studs.
  2. Verification of use of required design mixture.
  3. Concrete placement, including conveying and depositing.
  4. Curing procedures and maintenance of curing temperature.
  5. Verification of concrete strength before removal of shores and forms from beams and slabs.
  6. Batch Plant Inspections: On a random basis, as determined by Architect.
- E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
    - a. When frequency of testing provides 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.
  2. Slump: ASTM C143/C143M:
    - a. 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.
    - b. Perform additional tests when concrete consistency appears to change.
  3. Slump Flow: ASTM C1611/C1611M:
    - a. 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.
    - b. Perform additional tests when concrete consistency appears to change.
  4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete;
    - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  5. Concrete Temperature: ASTM C1064/C1064M:
    - a. One test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample.

6. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
  - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C31/C31M:
  - a. Cast, initial cure, and field cure two sets of four standard cylinder specimens for each composite sample.
8. Compressive-Strength Tests: ASTM C39/C39M.
  - a. Test one set of two laboratory-cured specimens at seven days and one set of two specimens at 28 days.
  - b. Test one set of two field-cured specimens at seven days and one set of two specimens at 28 days.
  - c. 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.
9. 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.
10. 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 (3.4 MPa).
11. 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.
12. Additional Tests:
  - a. 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.
  - b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
    - 1) Acceptance criteria for concrete strength shall be in accordance with ACI 301 (ACI 301M), section 1.6.6.3.
13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

- F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 (ASTM E1155M) within 72 hours of completion of floor finishing and promptly report test results to Architect.

### 3.16 PROTECTION

- A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION 033000

## SECTION 033543 - POLISHED CONCRETE FINISHING

### 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 polished concrete finishing and scoring
  - 1. Concrete for polished concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, initial finishing, and curing is specified in Section 033000 "Cast-in-Place Concrete."
- B. Related Requirements:
  - 1. Section 033000 "Cast-in-Place Concrete" for concrete not designated as polished concrete.

#### 1.3 DEFINITIONS

- A. Design Reference Sample: Sample designated by Architect in the Contract Documents that reflects acceptable surface quality and appearance of polished concrete.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 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 polished concrete to attend, including the following:
    - a. Contractor's superintendent.
    - b. Cast-in-place concrete subcontractor.
    - c. Polished concrete finishing Subcontractor.
  - 2. Review cold- and hot-weather concreting procedures, curing procedures, construction joints, concrete finishing, and protection of polished concrete.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Polishing Schedule: Submit plan showing polished concrete surfaces and schedule of polishing operations for each area of polished concrete before start of polishing operations. Include locations of all joints, including construction joints.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Material Certificates: For each of the following, signed by manufacturers:
  - 1. Liquid floor treatments.

## 1.7 QUALITY ASSURANCE

- A. Field Sample Panels: After approval of verification sample and before casting concrete, produce field sample panels to demonstrate the approved range of selections made under Sample submittals. Produce a minimum of three sets of full-scale panels, approximately 48 by 48 inches (1200 by 1200 mm) minimum, to demonstrate the expected range of finish, color, and appearance variations.

## 1.8 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

# PART 2 - PRODUCTS

## 2.1 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and is suitable for polished concrete surfaces.
- B. Comply with industry standards for OSHA and ADA non-slip requirements.

### PART 3 - EXECUTION

#### 3.1 POLISHING

- A. Polish: Match finish in existing school. Finish is to be Grade 1 with a Class 2, 800 grit polish.
- B. Apply polished concrete finish system to cured and prepared slabs to match accepted mockup.
  - 1. Machine grind floor surfaces to receive polished finishes level and smooth and to depth required to reveal aggregate to match floor surfaces in existing school.
  - 2. Apply reactive stain for polished concrete in polishing sequence and according to manufacturer's written instructions.
  - 3. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
  - 4. Continue polishing with progressively finer-grit diamond polishing pads to gloss level, to match concrete finish in existing school.
  - 5. Control and dispose of waste products produced by grinding and polishing operations.
  - 6. Neutralize and clean polished floor surfaces.

END OF SECTION 033543

## SECTION 051200 - 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. Section Includes:

- 1. Structural steel.
  - 2. Shrinkage-resistant grout.

- B. Related Requirements:

- 1. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other steel items not defined as structural steel.

#### 1.3 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.
- B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.
- C. Heavy Sections: Rolled and built-up sections as follows:
  - 1. Shapes included in ASTM A6/A6M with flanges thicker than 1-1/2 inches (38 mm).
  - 2. Welded built-up members with plates thicker than 2 inches (50 mm).
  - 3. Column base plates thicker than 2 inches (50 mm).
- D. Protected Zone: Structural members or portions of structural members indicated as "protected zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.
- E. Demand-Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the seismic-load-resisting system and which are indicated as "demand critical" or "seismic critical" on Drawings.

#### 1.4 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 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.

#### 1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.6 ACTION SUBMITTALS

- A. Product Data:
  - 1. Structural-steel materials.
  - 2. High-strength, bolt-nut-washer assemblies.
  - 3. Anchor rods.
  - 4. Threaded rods.
  - 5. Shop primer.
  - 6. Shrinkage-resistant grout.
- B. 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. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
  - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
  - 5. Identify members and connections of the seismic-load-resisting system.
  - 6. Indicate locations and dimensions of protected zones.
  - 7. Identify demand-critical welds.
  - 8. Identify members not to be shop primed.
- C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint whether prequalified or qualified by testing including the following:
  - 1. Power source (constant current or constant voltage).
  - 2. Electrode manufacturer and trade name, for demand-critical welds.

## 1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, fabricator, and testing agency.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Mill test reports for structural-steel materials, including chemical and physical properties.
- E. Product Test Reports: For the following:
  - 1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
  - 2. Direct-tension indicators.
  - 3. Tension-control, high-strength, bolt-nut-washer assemblies.
- F. Source quality-control reports.
- G. Field quality-control reports.

## 1.8 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).
- B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.
  - 1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

## 1.9 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 corrosion and deterioration.

1. 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.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
  1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
  2. Clean and relubricate bolts and nuts that become dry or rusty before use.
  3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Comply with applicable provisions of the following specifications and documents:
  1. ANSI/AISC 303.
  2. ANSI/AISC 341.
  3. ANSI/AISC 360.
  4. RCSC's "Specification for Structural Joints Using High-Strength Bolts."
- B. Connection Design Information:
  1. Option 1: Connection designs have been completed and connections indicated on the Drawings.
- C. Moment Connections: Type FR, fully restrained.
- D. Construction: Wood Shear wall system

### 2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A992/A992M
- B. Channels, Angles Shapes: ASTM A36/A36M
- C. Plate and Bar: ASTM A36/A36M, ASTM A572/A572M, Grade 50 (345) where designated as Grade 50.
- D. Cold-Formed Hollow Structural Sections: ASTM A500/A500M Grade C or ASTM A1085/ASTM A1085M structural tubing.
- E. Welding Electrodes: E70XX minimum. Comply with AWS requirements.

## STRUCTURAL STEEL FRAMING

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## 2.3 BOLTS AND CONNECTORS

- A. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, round head assemblies, consisting of steel structural bolts with splined ends; ASTM A563, Grade DH (ASTM A563M, Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: Plain

## 2.4 RODS

- A. Unheaded Anchor Rods: ASTM F1554, Grade 55, weldable

1. Configuration: Straight
2. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
3. Plate Washers: ASTM A36/A36M carbon steel.
4. Washers: ASTM F436 (ASTM F436M), Type 1, hardened carbon steel.
5. Finish: Plain

- B. Headed Anchor Rods: ASTM F1554, Grade 55, weldable

1. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
2. Plate Washers: ASTM A36/A36M carbon steel.
3. Washers: ASTM F436 (ASTM F436M), Type 1, hardened carbon steel.
4. Finish: Plain

## 2.5 PRIMER

- A. Steel Primer:

1. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

## 2.6 SHRINKAGE-RESISTANT GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

## 2.7 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.

1. Camber structural-steel members where indicated.

## STRUCTURAL STEEL FRAMING

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2. Fabricate beams with rolling camber up.
  3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
  4. Mark and match-mark materials for field assembly.
  5. 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/D1.1M.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
  2. Baseplate 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.

## 2.8 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

## 2.9 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.
1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
  2. Galvanize lintels attached to structural-steel frame and located in exterior walls.

## 2.10 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 (50 mm).
  2. Surfaces to be field welded.
  3. Surfaces of high-strength bolted, slip-critical connections.
  4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
  5. Galvanized surfaces unless indicated to be painted.
- B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:
1. SSPC-SP 2.
  2. SSPC-SP 3.
- C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner.
- D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
  2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

## 2.11 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage Engage a qualified testing agency to perform shop tests and inspections.
1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
  2. Bolted Connections: Inspect shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
  3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
    - a. Liquid Penetrant Inspection: ASTM E165/E165M.
    - b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    - c. Ultrasonic Inspection: ASTM E164.

- d. Radiographic Inspection: ASTM E94/E94M.
- 4. Prepare test and inspection reports.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
  - 1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- 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 on Drawings.
  - 1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing 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 in accordance with ANSI/AISC 303 and ANSI/AISC 360.
- B. Baseplates: Clean concrete-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
  - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
  - 2. Weld plate washers to top of baseplate.
  - 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 plate before packing with grout.
  - 4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.

- C. Maintain erection tolerances of structural steel within ANSI/AISC 303.
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
  - 1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
  - 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 use thermal cutting during erection unless approved by Engineer. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

### 3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.
  - 1. Joint Type: Snug tightened
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
  - 1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
  - 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
  - 3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

### 3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:
  - 1. Verify structural-steel materials and inspect steel frame joint details.
  - 2. Verify weld materials and inspect welds.
  - 3. Verify connection materials and inspect high-strength bolted connections.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

1. Bolted Connections: Inspect bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.
  - a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
    - 1) Liquid Penetrant Inspection: ASTM E165/E165M.
    - 2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    - 3) Ultrasonic Inspection: ASTM E164.
    - 4) Radiographic Inspection: ASTM E94/E94M.

### 3.6 PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
  1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

END OF SECTION 051200

## SECTION 054000 - COLD-FORMED METAL 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. Section Includes:

- 1. Exterior non-load-bearing wall framing.
  - 2. Interior non-load-bearing wall framing exceeding height limitations of standard, nonstructural metal framing.
  - 3. Soffit framing.

- B. Related Requirements:

- 1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
  - 2. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies, with height limitations.
  - 3. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings:

- 1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
  - 2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

- C. Delegated-Design Submittal: For cold-formed steel framing.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Product Certificates: For each type of code-compliance certification for studs and tracks.
- D. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.
  - 1. Steel sheet.
  - 2. Expansion anchors.
  - 3. Power-actuated anchors.
  - 4. Mechanical fasteners.
  - 5. Vertical deflection clips.
  - 6. Horizontal drift deflection clips
  - 7. Miscellaneous structural clips and accessories.
- E. Evaluation Reports: For nonstandard cold-formed steel framing, post-installed anchors, and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

#### 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Stud Manufacturers Association.
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ClarkDietrich Building Systems.
  2. Nuconsteel, A Nucor Company.
  3. SCAFCO Corporation.
  4. Steel Construction Systems.
  5. Steel Network, Inc. (The).
  6. Steel Structural Systems.
  7. Steeler, Inc.
  8. United Metal Products, Inc.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.
- B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
1. Design Loads: As indicated on Drawings.
  2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
    - a. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/360 of the wall height.
    - b. Interior Non-Load-Bearing Framing: Horizontal deflection of 1/240 of the wall height under a horizontal load of 5 lbf/sq. ft. (239 Pa).
    - c. Ceiling Joist Framing: Vertical deflection of 1/360 of the span for live loads and 1/240 for total loads of the span.
  3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F (67 deg C).
  4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
    - a. Upward and downward movement of 3/4 inch (19 mm).

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
- C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:
  1. Floor and Roof Systems: AISI S210.
  2. Wall Studs: AISI S211.
  3. Headers: AISI S212.
  4. Lateral Design: AISI S213.
- D. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

## 2.3 COLD-FORMED STEEL FRAMING MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
  1. Grade: As required by structural performance.
  2. Coating: G60 (Z180).
- C. Steel Sheet for Vertical Deflection and Drift Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
  1. Grade: As required by structural performance.
  2. Coating: G60 (Z180).

## 2.4 FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
  1. Minimum Base-Metal Thickness: As required by structural performance.
  2. Flange Width: 1-5/8 inches (41 mm).
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
  1. Minimum Base-Metal Thickness: As required by structural performance.

2. Flange Width: 1-1/4 inches (32 mm).
- C. Vertical Deflection Clips: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
  1. Minimum Base-Metal Thickness: 0.05 inch (1.27 mm).
  2. Flange Width: 1 inch (25 mm) plus the design gap for one-story structures and 1 inch (25 mm) plus twice the design gap for other applications.
- E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

## 2.5 INTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
  1. Minimum Base-Metal Thickness: 0.05 inch (1.27 mm).
  2. Flange Width: 1-5/8 inches (41 mm).
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
  1. Minimum Base-Metal Thickness: 0.05 inch (1.27 mm).
  2. Flange Width: 1-1/4 inches (32 mm).
- C. Vertical Deflection Clips: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
  1. Minimum Base-Metal Thickness: 0.05 inch (1.27 mm).
  2. Flange Width: 1 inch (25 mm) plus the design gap for one-story structures and 1 inch (25 mm) plus twice the design gap for other applications.

- E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

## 2.6 SOFFIT FRAMING

- A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
  - 1. Minimum Base-Metal Thickness: 0.05 inch (1.27 mm).
  - 2. Flange Width: 1-5/8 inches (41 mm), minimum.

## 2.7 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
  - 1. Supplementary framing.
  - 2. Bracing, bridging, and solid blocking.
  - 3. Web stiffeners.
  - 4. Anchor clips.
  - 5. End clips.
  - 6. Foundation clips.
  - 7. Gusset plates.
  - 8. Stud kickers and knee braces.
  - 9. Joist hangers and end closures.
  - 10. Hole-reinforcing plates.
  - 11. Backer plates.

## 2.8 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.
- C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.

1. Uses: Securing cold-formed steel framing to structure.
  2. Type: Torque-controlled expansion anchor or adhesive anchor.
  3. 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.
  4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).
- D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.
- F. Welding Electrodes: Comply with AWS standards.

## 2.9 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A 780/A 780M.
- B. Cement Grout: Portland cement, ASTM C 150/C 150M, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C 1107/C 1107M, and with a fluid consistency and 30-minute working time.
- D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.
- E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

## 2.10 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
1. Fabricate framing assemblies using jigs or templates.
  2. Cut framing members by sawing or shearing; do not torch cut.

3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
    - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    - b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
  4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.
- C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet (1:960) and as follows:
1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
  2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

- C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch (6 mm) to ensure a uniform bearing surface on supporting concrete or masonry construction.
- D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

### 3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
  - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch (1.6 mm).
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
  - 1. Cut framing members by sawing or shearing; do not torch cut.
  - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
    - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    - b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

- H. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

#### 3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
  - 1. Stud Spacing: As indicated on Drawings.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
  - 1. Install single deep-leg deflection tracks and anchor to building structure.
  - 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
  - 3. Connect vertical deflection clips to studs and anchor to building structure.
  - 4. Connect drift clips to cold-formed steel framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches (1220 mm) apart. Fasten at each stud intersection.
  - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
  - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
  - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches (305 mm) of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
  - 1. Install solid blocking at centers indicated on Shop Drawings.

- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

### 3.5 INTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
  - 1. Stud Spacing: As indicated on Drawings.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
  - 1. Install single deep-leg deflection tracks and anchor to building structure.
  - 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
  - 3. Connect vertical deflection clips to studs and anchor to building structure.
  - 4. Connect drift clips to cold-formed steel metal framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches (1220 mm) apart. Fasten at each stud intersection.
  - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
  - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
  - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches (305 mm) of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
  - 1. Install solid blocking at centers indicated on Shop Drawings.
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

### 3.6 JOIST INSTALLATION

- A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.
- B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
  - 1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm).
  - 2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections.
- C. Space joists not more than 2 inches (51 mm) from abutting walls, and as follows:
  - 1. Joist Spacing: As indicated on Drawings.
- D. Frame openings with built-up joist headers, consisting of joist and joist track or another combination of connected joists if indicated.
- E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement.
  - 1. Install web stiffeners to transfer axial loads of walls above.
- F. Install bridging at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:
  - 1. Joist-Track Solid Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
  - 2. Combination Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.
- G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.
- H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

### 3.7 ERECTION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

### 3.8 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

### 3.9 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

## SECTION 055000 - METAL FABRICATIONS

### 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. Steel framing and supports for countertops.
2. Steel framing and supports for mechanical and electrical equipment.
3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
4. Shelf angles.
5. Miscellaneous steel trim including steel angle corner guards.
6. Metal bollards.
7. Downspout guards.
8. Abrasive metal nosings, treads and thresholds.
9. Metal downspout boots.

- B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

- C. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 051200 "Structural Steel Framing".
3. Section 055213 "Pipe and Tube Railings".

### 1.3 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.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Nonslip aggregates and nonslip-aggregate surface finishes.
  - 2. Prefabricated building columns.
  - 3. Metal nosings and treads.
  - 4. Paint products.
  - 5. Grout.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
  - 1. Steel framing and supports for countertops.
  - 2. Steel framing and supports for mechanical and electrical equipment.
  - 3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
  - 4. Elevator machine beams, hoist beams, and divider beams.
  - 5. Metal bollards.
  - 6. Abrasive metal nosings, treads and thresholds.
  - 7. Loose steel lintels.

### 1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

### 1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS

- A. Metal Surfaces, General: 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. 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.
- D. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- E. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.
- F. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.3 FASTENERS

- A. General: 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

METAL FABRICATIONS

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(ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
  2. Provide stainless-steel fasteners for fastening stainless steel.
  3. Provide stainless-steel fasteners for fastening nickel silver.
  4. Provide bronze fasteners for fastening bronze.
- B. 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.
- C. 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.
- D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- E. Anchors, General: 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.
- F. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- G. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
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.

## 2.4 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide product compatible with system as required per Sections 099113 "Exterior Painting," 099123 "Interior Painting," as appropriate for location and painting system indicated.
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

## METAL FABRICATIONS

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1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- C. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- D. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- G. 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.
- H. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

## 2.5 FABRICATION, GENERAL

- A. Shop Assembly: 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.
- B. 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.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply 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.
- F. 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.

- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. 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.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches (3.2 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.

## 2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. 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.
  - 1. Fabricate units from slotted channel framing where indicated.
  - 2. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with high performance primer.

## 2.7 SHELF ANGLES

- A. 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.
  - 1. Provide mitered and welded units at corners.
  - 2. 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.
- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
- C. Galvanize and prime shelf angles located in exterior walls.

- D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

## 2.8 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. 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.
- C. Galvanize and prime exterior miscellaneous steel trim.
- D. Prime exterior miscellaneous steel trim with high performance primer.

## 2.9 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 40 steel pipe unless indicated otherwise.
  - 1. Cap bollards with 1/4-inch- (6.4-mm-) thick steel plate.

## 2.10 DOWNSPOUT GUARDS

- A. Fabricate downspout guards from 3/8-inch- (9.5-mm-) thick by 12-inch- (300-mm-) wide steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch (50-mm) clearance between pipe and pipe guard. Drill each end for two 3/4-inch (19-mm) anchor bolts.
- B. Galvanize and prime downspout guards.

## 2.11 ABRASIVE METAL NOSINGS, TREADS AND THRESHOLDS

- A. Cast-Metal Units: Cast iron, with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
  - 1. Nosings: Cross-hatched units, 4 inches (100 mm) wide with 1-inch (25-mm) lip, for casting into concrete.
  - 2. Nosings: Cross-hatched units, 1-1/2 by 1-1/2 inches (38 by 38 mm), for casting into concrete.

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3. Treads: Cross-hatched units, full depth of tread with 3/4-by-3/4-inch (19-by-19-mm) nosing, for application over bent plate treads or existing stairs.
  4. Thresholds: Fluted-saddle-type units, 5 inches (125 mm) wide by 1/2 inch (12 mm) high, with tapered edges.
  5. Thresholds: Fluted-interlocking- (hook-strip-) type units, 5 inches (125 mm) wide by 5/8 inch (16 mm) high, with tapered edge.
  6. Thresholds: Plain-stepped- (stop-) type units, 5 inches (125 mm) wide by 1/2 inch (12 mm) high, with 1/2-inch (12-mm) step.
- B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- C. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches (100 mm) from ends and not more than 12 inches (300 mm) o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.
1. Provide two rows of holes for units more than 5 inches (125 mm) wide, with two holes aligned at ends and intermediate holes staggered.
- D. Apply bituminous paint to concealed surfaces of cast-metal units.

## 2.12 METAL DOWNSPOUT BOOTS

- A. Provide downspout boots made from cast iron in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.
1. Outlet: Vertical, to discharge into pipe.

## 2.13 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches (200 mm) unless otherwise indicated.
- C. Galvanize and prime loose steel lintels located in exterior walls.

## 2.14 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.15 FINISHES, GENERAL

- 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.

2.16 STEEL AND IRON FINISHES

- A. Galvanizing: 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.
  - 1. 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.
  - 1. Shop prime with primers specified in Section 099113 "Exterior Painting", primers specified in Section 099123 "Interior Painting"
- D. Preparation for Shop Priming: Clean surfaces to be painted per primer manufacturer's written instructions. Remove loose rust and mill scale and other spatter, slag, flux deposits, and any other potential bond-breaking materials.
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
  - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 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 are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

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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: Comply with the following requirements:
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. 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: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
1. Cast Aluminum: Heavy coat of bituminous paint.

### 3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

### 3.3 INSTALLING METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
- B. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

### 3.4 INSTALLING PIPE GUARDS

- A. Provide pipe guards at exposed vertical pipes in parking garage where not protected by curbs or other barriers. Install by bolting to wall or column with expansion anchors. Provide four 3/4-inch (19-mm) bolts at each pipe guard. Mount pipe guards with top edge 26 inches (660 mm) above driving surface.

### 3.5 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

- A. Center nosings on tread widths unless otherwise indicated.
- B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.
- C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 079200 "Joint Sealants" to provide a watertight installation.

### 3.6 ADJUSTING AND CLEANING

- A. Touchup Painting: 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.
  - 1. 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 099113 "Exterior Painting." and Section 099123 "Interior Painting."
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 055000

## SECTION 055213 - PIPE AND TUBE RAILINGS

### 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. Steel pipe and tube railings.
  - 2. Stainless-steel pipe and tube railings.

#### 1.3 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.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Manufacturer's product lines of mechanically connected railings.
  - 2. Railing brackets.
  - 3. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Fittings and brackets.
3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
  - a. Show method of connecting and finishing members at intersections.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
- E. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.
- F. Evaluation Reports: For post-installed anchors, from ICC-ES.

#### 1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
  1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

#### 1.7 DELIVERY, STORAGE, AND HANDLING

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

#### 1.8 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Pisor Industries, Inc.
  2. Sharpe Products.
  3. Standard Steel Fabricating Co., Seattle, WA
  4. Totem Steel Fabricators, Inc., Woodinville, WA.
  5. Wagner, R & B, Inc.; a division of the Wagner Companies.
  6. Welding Fabrication, LLC, Auburn, WA.
  7. Source Limitations: Obtain each type of railing from single
- B. Source Limitations: Obtain each type of railing from single source from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.
- B. Structural Performance: 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:
1. Handrails and Top Rails of Guards:
    - a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
    - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
    - c. Uniform and concentrated loads need not be assumed to act concurrently.
  2. Infill of Guards:
    - a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
    - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C, material surfaces

## 2.3 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
  - 1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch (38-mm) clearance from inside face of handrail to finished wall surface.

## 2.4 STEEL AND IRON

- A. Tubing: ASTM A 500 (cold formed) or ASTM A 513.
- B. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
  - 1. Provide galvanized finish for exterior installations and where indicated.
- C. Plates, Shapes, and Bars: ASTM A 36/A 36M.
  - 1. Style Designation: Per drawings
- D. Perforated Metal: Cold-rolled steel sheet, ASTM A 1008/A 1008M, or hot-rolled steel sheet, ASTM A 1011/A 1011M, commercial steel Type B, pattern and thickness per drawings.

## 2.5 FASTENERS

- A. General: Provide the following:
  - 1. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 for zinc coating.
  - 2. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.
  - 3. Stainless-Steel Railings: Type 304 stainless-steel fasteners.
  - 4. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. 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 concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
  3. Provide Phillips flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 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.
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: Alloy Group 1 (A1 stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

## 2.6 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
1. For aluminum and stainless-steel railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Shop Primers: Provide product compatible with system as required per Sections 099113 "Exterior Painting," 099123 "Interior Painting," for location and painting system indicated.
- E. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- F. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- G. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

- H. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.
- I. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.
- J. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- K. 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.
- L. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
  - 1. Water-Resistant Product: At exterior locations and where indicated provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

## 2.7 FABRICATION

- A. General: 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 welded connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
  - 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 flux immediately.
  4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- J. Form Changes in Direction as Follows:
1. As detailed.
  2. By flush bends or by inserting prefabricated flush-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: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
1. 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 6 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. Expanded-Metal Infill Panels: Fabricate infill panels from expanded metal made from same metal as railings in which they are installed.
1. Edge panels with U-shaped channels made from metal sheet, of same metal as expanded metal and not less than 0.043 inch (1.1 mm) thick, unless shown otherwise on drawings.
  2. Orient expanded metal as indicated on Drawings.

- 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.
- S. Steel Grating: For infill panels, treads and risers as shown on drawings.

## 2.8 STEEL AND IRON FINISHES

### A. Galvanized Railings:

1. Hot-dip galvanize exterior steel railings, including hardware, after fabrication.
2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
3. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
4. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
5. 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.

- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

- D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, galvanize anchors to be embedded in exterior concrete or masonry.

- E. Preparation for Shop Priming: Clean surfaces to be painted per primer manufacturer's written instructions. Remove loose rust and mill scale and other spatter, slag, flux deposits, and any other potential bond-breaking materials.

- F. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

1. Exterior Railings: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Railings Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Railings Indicated to Receive Primers: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Railings: SSPC-SP 3, "Power Tool Cleaning."

- G. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Shop prime uncoated railings with universal shop primer

2. Do not apply primer to galvanized surfaces.
3. Color: As selected by Architect from manufacturer's full range.

## 2.9 STAINLESS-STEEL FINISHES

- A. Remove tool and die marks and stretch lines, or blend into finish.
- B. 180-Grit Polished Finish: Oil-ground, uniform, directionally textured finish.
- C. Directional Satin Finish: No. 4.
- D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

## PART 3 - EXECUTION

### 3.1 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.

### 3.2 INSTALLATION, GENERAL

- 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 3 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 mm in 3.5 m).
- C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
  1. 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.

## PIPE AND TUBE RAILINGS

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- 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.

### 3.3 RAILING CONNECTIONS

- A. Nonwelded 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 in "Fabrication" Article 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 2 inches (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

### 3.4 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 nonshrink, 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 5 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 nonshrink, nonmetallic grout or anchoring cement mixed and placed to comply with anchoring material manufacturer's written instructions.
- C. 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 as follows:
  - 1. For stainless-steel pipe railings, weld flanges to post and bolt to supporting surfaces.
  - 2. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

### 3.5 ATTACHING RAILINGS

- A. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends or connected to railing ends using nonwelded connections.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded 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.
  - 2. For hollow masonry anchorage, use toggle bolts.
  - 3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
  - 4. For steel-framed partitions, use hanger or lag bolts set into fire-retardant-treated wood backing between studs. Coordinate with stud installation to locate backing members.
  - 5. For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
  - 6. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

### 3.6 ADJUSTING AND CLEANING

- A. Clean aluminum and stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.
- B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.
  - 1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
- C. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting".
- D. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

### 3.7 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 055213

## SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

### 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. Rooftop equipment bases and support curbs.
  - 2. Wood blocking, cants, and nailers.
  - 3. Wood furring and grounds.
  - 4. Wood sleepers.
  - 5. Plywood backing panels.

- B. Related Requirements:

- 1. Section 061600 "Sheathing" for sheathing, subflooring, and underlayment".
  - 2. Section 062023 "Interior Finish Carpentry".
  - 3. Section 075423 "Thermoplastic polyolefin (TPO) roofing".
  - 4. Section 076200 "Sheet metal flashing and trim".

#### 1.3 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal (38 mm actual) size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater size but less than 5 inches nominal (114 mm actual) size in least dimension.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
  - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
  - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include

physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

## 1.5 INFORMATIONAL SUBMITTALS

### A. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.
4. Post-installed anchors.
5. Metal framing anchors.

## 1.6 QUALITY ASSURANCE

- ### A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- ### A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

# PART 2 - PRODUCTS

## 2.1 WOOD PRODUCTS, GENERAL

- ### A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
  2. Dress lumber, S4S, unless otherwise indicated.

- B. Maximum Moisture Content of Lumber: 15 percent unless otherwise indicated.

## 2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWPAC U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
  2. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
- D. Application: Treat all miscellaneous carpentry unless otherwise indicated.

## 2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
1. Treatment shall not promote corrosion of metal fasteners.
  2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.

3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
  4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D 5664, and design value adjustment factors shall be calculated according to ASTM D 6841.
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.
- E. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not bleed through, contain colorants, or otherwise adversely affect finishes.
- F. Application: Treat all miscellaneous carpentry unless otherwise indicated.

## 2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
1. Blocking.
  2. Nailers.
  3. Rooftop equipment bases and support curbs.
  4. Cants.
  5. Furring.
  6. Grounds.
- B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.
- C. Concealed Boards: 15 percent maximum moisture content of the following species and grades:
1. Hem-fir or hem-fir (north), Construction or No. 2 Common grade; NLGA, WCLIB, or WWP.
- D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

- F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

## 2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.

## 2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
  - 1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Screws for Fastening to Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.
- D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC58, ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.
  - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

## 2.7 METAL FRAMING ANCHORS

- A. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
  - 1. Use for interior locations unless otherwise indicated.
- B. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch (0.9 mm) thick.

1. Use for wood-preservative-treated lumber and where indicated.

## 2.8 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
- C. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- D. Do not splice structural members between supports unless otherwise indicated.
- E. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
  1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.
- F. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
  1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
  2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438 mm) o.c. Where fire

- blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal (38-mm actual) thickness.
3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. (9.3 sq. m) and to solidly fill space below partitions.
  4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (6 m) o.c.
- G. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- H. Comply with AWP A M4 for applying field treatment to cut surfaces of preservative-treated lumber.
1. Use inorganic boron for items that are continuously protected from liquid water.
  2. Use copper naphthenate for items not continuously protected from liquid water.
- I. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- J. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
  2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
  3. ICC-ES evaluation report for fastener.
- K. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.
- 3.2 WOOD BLOCKING AND NAILER INSTALLATION
- A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

### 3.3 WOOD FURRING INSTALLATION

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

### 3.4 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

## SECTION 061600 - SHEATHING

### 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. Wall sheathing.
2. Parapet sheathing.
3. Sheathing joint and penetration treatment.

- B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for plywood backing panels.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.
4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

#### 1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that

periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: As tested according to ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

### 2.2 WALL SHEATHING

- A. Glass-Mat Gypsum Sheathing: ASTM C 1177/1177M.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide Dens-Glass Gold by G-P Gypsum Corporation, or comparable product by, but not limited to, one of the following:
    - a. American Gypsum.
    - b. LaFarge North America Inc.
    - c. National Gypsum Company.
    - d. Temple-Inland Inc.
    - e. United States Gypsum Co.
  - 2. Type and Thickness: Regular, 1/2 inch thick.
  - 3. Size: 48 by 96 inches for vertical installation.

### 2.3 PARAPET SHEATHING

- A. Glass-Mat Gypsum Sheathing: ASTM C 1177/1177M.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide Dens-Glass Gold by G-P Gypsum Corporation, or comparable product by, but not limited to, one of the following:
    - a. American Gypsum.

- b. LaFarge North America Inc.
  - c. National Gypsum Company.
  - d. Temple-Inland Inc.
  - e. United States Gypsum Co.
2. Type and Thickness: Regular, 1/2 inch thick.
3. Size: 48 by 96 inches for vertical installation.

## 2.4 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
  1. For parapet and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Screws for Fastening Sheathing to Wood Framing: ASTM C 1002.
- E. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
  1. For steel framing less than 0.0329 inch (0.835 mm) thick, use screws that comply with ASTM C 1002.
  2. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, use screws that comply with ASTM C 954.

## 2.5 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Glass-Mat Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Section 079200 "Joint Sealants."

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

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- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
  - 1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
- D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
- E. Coordinate parapet and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

### 3.2 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
  - 1. Fasten gypsum sheathing to cold-formed metal framing with screws.
  - 2. Install panels with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
  - 3. Install panels with a 1/4-inch (6.4-mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
- C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.
  - 1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.
  - 2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.
- D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.
  2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.
- E. Seal sheathing joints according to sheathing manufacturer's written instructions.
1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
  2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

END OF SECTION 061600

## SECTION 062023 - INTERIOR FINISH CARPENTRY

### 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. Interior MDF paneling (MDF-#).

- B. Related Requirements:

- 1. Section 061053 "Miscellaneous Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view, and equipment backup panels.
  - 2. Section 099123 "Interior Painting" for priming and backpriming of interior finish carpentry for opaque finishes.
  - 3. Color and Finish Schedule on the Drawings.

#### 1.3 DEFINITIONS

- A. WI – Woodwork Institute; <http://woodworkinstitute.com>; 916-372-9943.
- B. NAAWS - Definitions in the "North American Architectural Woodwork Standards" (NAAWS), latest edition, apply to the Work of this Section. 3.1 or latest edition, jointly published by the Woodwork Institute (WI) and the Architectural Woodwork Manufacturers Association of Canada (AWMAC)
  - 1. For free downloads in PDF format, [www.naaws-committee.com](http://www.naaws-committee.com).
- C. CCP – Certified Compliance Program. <https://woodworkinstitute.com/services/certified-compliance-program/>.

#### 1.4 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that architectural woodwork can be supported and installed as indicated.

## 1.5 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.
  - 1. Include data for wood-preservative treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained. Include chemical-treatment manufacturer's written instructions for finishing treated material.
  - 2. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
  - 3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced before shipment to Project site to levels specified.
- B. Samples for Verification:
  - 1. For each species and cut of lumber products with nonfactory-applied finish, with half of exposed surface finished, 50 sq. in. for lumber.
  - 2. For each finish system and color of lumber products with factory-applied finish, 50 sq. in. for lumber.
- C. Evaluation Reports: For fire-retardant-treated wood, from ICC-ES.

## 1.6 QUALITY ASSURANCE

- A. Fabricator and Installer Qualifications: Employs skilled workers who fabricate and install products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a certified participant in WI's Quality Certification Program.
  - 1. Woodwork manufacturers and installers do not need to be members of WI nor an Accredited Millwork Company (AMC) for their work product to be inspected and certified in compliance with the NAAWS. It is the achievement of compliance with the standards on each project and not prior membership that is of paramount necessity.
  - 2. The woodwork manufacturer must have at least one project in the past 5 years where the value of the woodwork was within 20 percent of the cost of woodwork for this project.
- B. Installer Qualifications: Certified participant in WI's Quality Certification Program.
- C. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
- D. Mockups: Build sample mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

- E. At completion of installation, provide a Woodwork Institute Certified Compliance Certificate indicating the products installed and certifying that the installation of these products fully meets the requirements of the grade or grades specified.
- F. All fees charged by the Woodwork Institute for its Certified Compliance program are the responsibility of the millwork manufacturer and/or installer and shall be included in their bid as a line item in the Scope of Work to be later billed to the project owner.
- G. Overage: Ensure appropriate amount of overage to account for quality requirement; for all WD-# types allow for approximately 25 percent additional materials to allow sorting and rejecting to meet quality requirements.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of the NAAWS Section 2 Care and Storage.
- B. Stack lumber flat with spacers between each bundle to provide air circulation. Protect materials from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.
- C. Deliver interior finish carpentry materials only when environmental conditions comply with requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions comply with requirements specified for installation areas.

#### 1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period. Maintain temperature and relative humidity during remainder of construction period in range recommended for Project location by the "North American Architectural Woodwork Standards."
- B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.
  - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

## PART 2 - PRODUCTS

### 2.1 ARCHITECTURAL WOODWORK, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the "North American Architectural Woodwork Standards" for grades of interior finish carpentry indicated for construction, finishes, installation, and other requirements.
  - 1. Provide labels and certificates from WI's certification program indicating that woodwork, including installation, complies with requirements of grades specified.
  - 2. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.

### 2.2 MATERIALS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the American Lumber Standard Committee's Board of Review. Grade lumber by an agency certified by the American Lumber Standard Committee's Board of Review to inspect and grade lumber under the rules indicated.
  - 1. Factory mark each piece of lumber with grade stamp of grading agency.
  - 2. For exposed lumber, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
- B. Softwood Plywood: DOC PS 1.
- C. Medium Density Fiberboard (MDF): ANSI A208.2, Grade 130.

### 2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: For applications indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and comply with testing requirements; testing will be conducted by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
  - 1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.

- C. For exposed items indicated to receive a stained or natural finish, use organic resin chemical formulations that do not contain colorants, and provide materials that do not have marks from spacer sticks on exposed face.
- D. Do not use material that does not comply with requirements for untreated material or is warped or discolored.
- E. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
  - 1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
  - 2. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.
- F. Medium Density Fiberboard, (MDF-1):
  - 1. Basis-of-Design Product: Medex moisture-resistant MDF by Roseburg Lumber; [www.roseburg.com](http://www.roseburg.com).
  - 2. Material Standard: ANSI A208.2, with formaldehyde-free adhesive system.
  - 3. Size Thickness: As specified in Color and Finish Schedule on Drawings.
  - 4. Finish: As specified in Color and Finish Schedule on Drawings.
  - 5. Class C fire rated.

## 2.4 MISCELLANEOUS MATERIALS

- A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.
- B. Low-Emitting Materials: Adhesives 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."
- C. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.
- D. Multipurpose Construction Adhesive: Formulation complying with ASTM D3498 that is recommended for indicated use by adhesive manufacturer.

## 2.5 FABRICATION

- A. Back out or kerf backs of the following members, except those with ends exposed in finished work:

1. Interior standing and running trim, except shoe and crown molds.
- B. Ease edges of lumber less than 1-inch in nominal thickness to 1/16-inch radius and edges of lumber 1-inch or more in nominal thickness to 1/8-inch radius.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.
- B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

#### 3.3 INSTALLATION, GENERAL

- A. Do not use materials that are unsound; warped; improperly treated or finished; inadequately seasoned; too small to fabricate with proper jointing arrangements; or with defective surfaces, sizes, or patterns.
- B. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
  1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
  2. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
  3. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining interior finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
  4. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.4 FIELD QUALITY CONTROL

- A. Inspections: Provide inspection of installed Work through WI's Certified Compliance Program certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.
  - 1. Inspection entity shall prepare and submit report of inspection.

3.5 ADJUSTING

- A. Replace interior finish carpentry that is damaged or does not comply with requirements. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

3.6 CLEANING

- A. Clean interior finish carpentry on exposed and semi-exposed surfaces. Restore damaged or soiled areas and touch up factory-applied finishes if any.

3.7 PROTECTION

- A. Protect installed products from damage from weather and other causes during construction.
- B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
  - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 062023

## SECTION 070150.19 - PREPARATION FOR REROOFING

### 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. Additional Related Sections
  - 1. 017300 Execution.
  - 2. 075423 Thermoplastic Polyolefin (TPO) Roofing.

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Patching and work at new mechanical rooftop unit curbs.
  - 2. Temporary roofing.
  - 3. Protection of existing roof at area of work.

### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
  - 1. Include certificate that Installer is approved by warrantor of existing roofing system.

### 1.4 CLOSEOUT SUBMITTALS

- A. Certified statement from Carlisle stating that existing roof warranty has not been affected by Work performed under this Section.

### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Approved by warrantor of existing roofing system to work on existing roofing.

### 1.6 FIELD CONDITIONS

- A. Existing Roofing System: Roof was built in 2017 with a Carlisle product fully adhered elastic sheet membrane over original asphalt built-up roofing. Contractor to field verify. See assembly notes in drawings.

- B. Owner will not occupy portions of building immediately below reroofing area.
  - 1. Conduct reroofing so Owner's operations are not disrupted.
  - 2. Provide Owner with not less than 48 hours' written notice of activities that may affect Owner's operations.
  - 3. Coordinate work activities daily with Owner so Owner has adequate advance notice to place protective dust and water-leakage covers over sensitive equipment and furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below work area.
  - 4. Before working over structurally impaired areas of deck, notify Owner to evacuate occupants from below affected area.
    - a. Verify that occupants below work area have been evacuated before proceeding with work over impaired deck area.
- C. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.
- D. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
- E. Conditions existing at time of inspection for bidding will be maintained by Owner as far as practical.
  - 1. Record Drawings for existing roofing system can be provided for Contractor's convenience and information, but they are not a warranty of existing conditions. They are intended to supplement rather than serve in lieu of Contractor's own investigations. Contractor is responsible for conclusions derived from existing documents.
- F. Limit construction loads on existing roof areas to remain, and existing roof areas scheduled to be reroofed for rooftop equipment wheel loads and for uniformly distributed loads.
- G. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.
  - 1. Remove only as much roofing in one day as can be made watertight in the same day.
- H. Hazardous Materials: It is not expected that hazardous materials, such as asbestos-containing materials, will be encountered in the Work.
  - 1. Hazardous materials will be removed by Owner before start of the Work.
  - 2. Existing roof will be left no less watertight than before removal.
  - 3. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner.
    - a. Hazardous materials will be removed by Owner under a separate contract.

## 1.7 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during reroofing, by methods and with materials so as not to void existing roofing system warranty issued by Carlisle.
  - 1. Notify warrantor before proceeding with the Work.
  - 2. Notify warrantor of existing roofing system on completion of reroofing, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect.
    - a. Submit documentation at Project closeout.

## PART 2 - PRODUCTS

### 2.1 TEMPORARY PROTECTION MATERIALS

- A. EPS Insulation: ASTM C578.
- B. Plywood: DOC PS 1, Grade CD, Exposure 1.
- C. OSB: DOC PS 2, Exposure 1.

### 2.2 TEMPORARY ROOFING MATERIALS

- A. Design and selection of materials for temporary roofing are Contractor's responsibilities.

### 2.3 INFILL AND REPLACEMENT MATERIALS

- A. Use infill materials matching existing roofing system materials unless otherwise indicated.
- B. Steel deck is to match existing and to be reviewed by structural engineer.
- C. Wood blocking, curbs, and nailers are specified in "061053 Miscellaneous Rough Carpentry".
- D. Fasteners: Factory-coated steel fasteners with metal or plastic plates listed in FM Approvals' RoofNav, and acceptable to roofing system manufacturer.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protection of In-Place Conditions:

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1. Protect existing roofing system that is not to be reroofed.
2. Limit traffic and material storage to areas of existing roofing that have been protected.
3. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of reroofing.
4. Comply with requirements of existing roof system manufacturer's warranty requirements.

END OF SECTION 070150.19

## SECTION 071113 - BITUMINOUS DAMPPROOFING

### 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. Cold-applied, emulsified-asphalt dampproofing.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:

#### 1.4 FIELD CONDITIONS

- A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.
- B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS, GENERAL

- A. Source Limitations: Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide auxiliary materials recommended in writing by manufacturer of primary materials. Manufacturers to consider including the following:
  - 1. BASF.
  - 2. Tremco.

- B. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise required.

## 2.2 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. Trowel Coats: ASTM D 1227, Type II, Class 1.
- B. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.
- C. Brush and Spray Coats: ASTM D 1227, Type III, Class 1.

## 2.3 AUXILIARY MATERIALS

- A. General: Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.
- B. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.
- C. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.
- D. Patching Compound: As recommended in writing by dampproofing manufacturer.
- E. Protection Course: ASTM D 6506, 1/8-inch- (3-mm-) thick, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners.

## 2.4 MOLDED-SHEET DRAINAGE PANELS

- A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side of the core; and with a vertical flow rate of 9 to 15 gpm per ft. (112 to 188 L/min. per m).

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions with Applicator present, for compliance with requirements for surface smoothness, surface moisture, and other conditions affecting performance of bituminous dampproofing work.
  - 1. Test for surface moisture according to ASTM D 4263.

## BITUMINOUS DAMPPROOFING

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- B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.
- B. Clean substrates of projections and substances detrimental to the dampproofing work; fill voids, seal joints, and remove bond breakers if any, as recommended in writing by prime material manufacturer.
- C. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections; cover with asphalt-coated glass fabric.

### 3.3 APPLICATION, GENERAL

- A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless more stringent requirements are indicated.
  - 1. Apply dampproofing to provide continuous plane of protection.
  - 2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.
- B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches (150 mm) over outside face of footing.
  - 1. Extend dampproofing 12 inches (300 mm) onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
  - 2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as "reinforced," by embedding an 8-inch- (200-mm-) wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

### 3.4 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. Concrete Foundations and Parged Masonry Foundation Walls: Apply two brush or spray coats at not less than 1.5 gal./100 sq. ft. (0.6 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat, one fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m) or one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).

- B. Unparged Masonry Foundation Walls: Apply primer and two brush or spray coats at not less than 1.5 gal./100 sq. ft. (0.6 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat, primer and one fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m) or primer and one trowel coat at not less than 5 gal./100 sq. ft. (2 L/sq. m).
- C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).
- D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

### 3.5 INSTALLATION OF PROTECTION COURSE

- A. Where indicated, install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.
  - 1. Support protection course over cured coating with spot application of adhesive type recommended in writing by protection-board manufacturer.
  - 2. Install protection course within 24 hours of installation of dampproofing (while coating is tacky) to ensure adhesion.

### 3.6 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

- A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall substrate, according to manufacturer's written instructions. Use adhesives or other methods that do not penetrate dampproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
  - 1. Install protection course before installing drainage panels.

### 3.7 CLEANING

- A. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 071113

## SECTION 071900 - WATER REPELLENTS

### 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 film-forming water-repellent treatments for the following vertical and horizontal surfaces:
  - 1. Precast concrete.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include manufacturer's printed statement of VOC content.
  - 2. Include manufacturer's standard colors.
  - 3. Include manufacturer's recommended number of coats for each type of substrate and spreading rate for each separate coat.
- B. Samples: For each type of water repellent and substrate indicated, 12 by 12 inches (300 by 300 mm) in size, with specified water-repellent treatment applied to half of each Sample.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Applicator.
- B. Product Certificates: For each type of water repellent.
- C. Preconstruction Test Reports: For water-repellent-treated substrates.
- D. Field quality-control reports.

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- E. Sample Warranty: For special warranty.

## 1.6 QUALITY ASSURANCE

- A. Applicator Qualifications: An employer of workers trained and approved by manufacturer.
- B. MPI Standards: Comply with MPI standards indicated and provide water repellents listed in its "MPI Approved Products List."
- C. Mockups: Prepare mockups of each required water repellent on each type of substrate required to demonstrate aesthetic effects, for preconstruction testing, and to set quality standards for materials and execution.
1. Locate mockups in locations that enable viewing under same conditions as the completed Work.
    - a. Size: 10 sq. ft. each.
  2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing: Engage a qualified testing agency to perform preconstruction testing of water repellents on field mockups.
1. In addition to verifying performance requirements, use mockups to verify manufacturer's written instructions for application procedure and optimum rates of product application to substrates.
  2. Propose changes to materials and methods to suit Project.
  3. Notify Architect seven days in advance of the dates and times when mockups will be tested.

## 1.8 FIELD CONDITIONS

- A. Limitations: Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied according to manufacturers' written instructions and warranty requirements:
1. Concrete surfaces and mortar have cured for not less than 28 days.
  2. Building has been closed in for not less than 30 days before treating wall assemblies.

3. Ambient temperature is above 40 deg F (4.4 deg C) and below 100 deg F (37.8 deg C) and will remain so for 24 hours.
4. Substrate is not frozen and substrate-surface temperature is above 40 deg F (4.4 deg C) and below 100 deg F (37.8 deg C).
5. Rain or snow is not predicted within 24 hours.
6. Not less than 24 hours have passed since surfaces were last wet.
7. Windy conditions do not exist that might cause water repellent to be blown onto vegetation or surfaces not intended to be treated.

## 1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agree(s) to repair or replace materials that fail to maintain water repellency specified in "Performance Requirements" Article within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 FILM-FORMING WATER REPELLENTS

- A. Silicone-Resin Sealer, Film-Forming Water Repellent: Clear, polymerized, silicone-resin water repellent for dense substrates; in a solvent- or waterborne solution containing not less than 3 and up to 7 percent solids by weight.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide Omegaseal 333 manufactured by Diedrich Technologies, Inc. or comparable product by, but not limited to one of the following:
    - a. Dow Corning Corp.
    - b. Prosoco, Inc.
    - c. Evonik Corp.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements and conditions affecting performance of the Work.
  1. Verify that surfaces are clean and dry according to water-repellent manufacturer's requirements. Check moisture content in three representative locations by method recommended by manufacturer.

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2. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
  3. Verify that required repairs are complete, cured, and dry before applying water repellent.
- B. Test pH level according to water-repellent manufacturer's written instructions to ensure chemical bond to silica-containing or siliceous minerals.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. New Construction and Repairs: Allow concrete and other cementitious materials to age before application of water repellent, according to repellent manufacturer's written instructions.
- B. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product according to water-repellent manufacturer's written instructions.
- C. Protect adjoining work, including mortar and sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live vegetation.
- D. Coordination with Mortar Joints: Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water-repellent treatment has been installed and cured.
- E. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.
1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

### 3.3 APPLICATION

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.
- B. Apply coating of water repellent on surfaces to be treated using 15 psi- (103 kPa-) pressure spray with a fan-type spray nozzle to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Comply with manufacturer's written instructions for application procedure unless otherwise indicated.
1. Precast Concrete: At Contractor's option, first application of water repellent may be completed before installing units. Mask mortar and sealant bond surfaces to prevent

water repellent from migrating onto joint surfaces. Remove masking after repellent has cured.

- C. Apply a second saturation coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

### 3.4 FIELD QUALITY CONTROL

- A. Testing of Water-Repellent Material: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when water repellent is being applied:
  - 1. Owner will engage the services of a qualified testing agency to sample water-repellent material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
  - 2. Testing agency will perform tests for compliance of water-repellent material with product requirements.
  - 3. Owner may direct Contractor to stop applying water repellents if test results show material being used does not comply with product requirements. Contractor shall remove noncomplying material from Project site, pay for testing, and correct deficiency of surfaces treated with rejected materials, as approved by Architect. .
- B. Coverage Test: In the presence of Architect, hose down a dry, repellent-treated surface to verify complete and uniform product application. A change in surface color will indicate incomplete application.
  - 1. Notify Architect seven days in advance of the dates and times when surfaces will be tested.
  - 2. Reapply water repellent until coverage test indicates complete coverage.

### 3.5 CLEANING

- A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Correct damage to work of other trades caused by water-repellent application, as approved by Architect.
- B. Comply with manufacturer's written cleaning instructions.

END OF SECTION 071900

## SECTION 072100 - 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:

- 1. Extruded polystyrene foam-plastic board.
  - 2. Glass-fiber blanket.
  - 3. Mineral wool insulation.

- B. Related Requirements:

- 1. Section 072119 "Foamed-in-Place Insulation" for spray-applied polyurethane foam insulation.
  - 2. Section 075423 "Thermoplastic Polyolefin (TPO) Roofing" for insulation specified as part of roofing construction.
  - 3. Section 092900 "Gypsum Board" for sound attenuation blanket used as acoustic insulation.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- B. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

## 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.
- B. Protect foam-plastic board insulation as follows:
  - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
  - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
  - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

## PART 2 - PRODUCTS

### 2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD

- A. Extruded polystyrene boards in this article are also called "XPS boards." Roman numeral designators in ASTM C 578 are assigned in a fixed random sequence, and their numeric order does not reflect increasing strength or other characteristics.
- B. Extruded Polystyrene Board, Type IV: ASTM C 578, Type IV, 25-psi (173-kPa) minimum compressive strength; unfaced; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.
  - 1. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

### 2.2 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.

### 2.3 MINERAL WOOL SEMI-RIGID BOARD

- 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. Fibrex Insulations Inc.
  - 2. Isolatek International.
  - 3. Owens Corning.
  - 4. Roxul Inc.

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5. Thermafiber.

- B. Unfaced, Mineral-Wool Board Insulation: ASTM C 612; with maximum flame-spread and smoke-developed indexes of 15 and zero, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

1. Nominal density of 8 lb/cu. ft., Type III, thermal resistivity of 4.35 deg F x h x sq. ft./Btu x in. at 75 deg F.

2.3 INSULATION FASTENERS

- A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square.
2. 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, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
1. Angle: Formed from 0.030-inch- (0.762-mm-) thick, perforated, galvanized carbon-steel sheet with each leg 2 inches (50 mm) square.
2. 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: 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.
- D. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of dimension indicated 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.

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.

2. Spray Polyurethane Foam Insulation: ASTM C 1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

### PART 3 - EXECUTION

#### 3.1 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.

#### 3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. 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.

#### 3.3 INSTALLATION OF SLAB INSULATION

- A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
  1. If not otherwise indicated, extend insulation a minimum of 24 inches below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
  1. If not otherwise indicated, extend insulation a minimum of 24 inches in from exterior walls.

#### 3.4 INSTALLATION OF FOUNDATION WALL INSULATION

- A. Butt panels together for tight fit.

- B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.
  2. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings between concrete substrate and insulation.
  3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.
  4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.
- C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

### 3.5 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
1. 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.
  2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
  3. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
  4. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
  5. 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.
- B. 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.

3.6 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 072100

## SECTION 072119 - FOAMED-IN-PLACE 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:
  - 1. Closed-cell spray polyurethane foam.
- B. Related Requirements:
  - 1. Section 072100 "Thermal Insulation" for foam-plastic board insulation.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

## PART 2 - PRODUCTS

### 2.1 CLOSED-CELL SPRAY POLYURETHANE FOAM

- A. Closed-Cell Spray Polyurethane Foam: ASTM C 1029, Type II, minimum density of 2.1 lb/cu. ft. and minimum aged R-value at 1-inch (25.4-mm) thickness of 7.4 deg F x h x sq. ft./Btu at 75 deg F
1. Basis-of-Design Product: Subject to compliance with requirements, provide Heatlok Soy 200+ or comparable product by, but not limited to one of the following:
    - a. Icynene, Inc.
    - b. Dow Corning Corp.
    - c. Certainteed Corp.
  2. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
    - a. Flame-Spread Index: 25 or less.
    - b. Smoke-Developed Index: 450 or less.
  3. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

### 2.2 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by insulation manufacturer where required for adhesion of insulation to substrates.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Verify that substrates are clean, dry, and free of substances that are harmful to insulation.
- B. 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.

### 3.2 INSTALLATION

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Spray insulation to envelop entire area to be insulated and fill voids.

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- C. Apply in multiple passes to not exceed maximum thicknesses recommended by manufacturer. Do not spray into rising foam.
- D. Framed Construction: Install into cavities formed by framing members to achieve thickness indicated on Drawings.
- E. Cavity Walls: Install into cavities to thickness and/or R value indicated on Drawings.
- F. Miscellaneous Voids: Apply according to manufacturer's written instructions.

### 3.3 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

END OF SECTION 072119

## SECTION 072600 - VAPOR RETARDERS

### 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. Reinforced-polyethylene vapor retarders.
- B. Related Requirements:
  - 1. Section 033000 "Cast-in-Place Concrete" for under-slab vapor retarders.
  - 2. Section 075423 "Thermoplastic Polyolefin (TPO) Roofing" for vapor retarders in roofing assembly.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

### PART 2 - PRODUCTS

#### 2.1 REINFORCED-POLYETHYLENE VAPOR RETARDERS

- A. Reinforced-Polyethylene Vapor Retarders: Sheet with outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nylon cord or polyester scrim and weighing not less than 29 lb/1000 sq. ft. (13 kg/100 sq. m), with maximum permeance rating of 0.1 perm (5.7 ng/Pa x s x sq. m). Thickness not to be less than 0.010 inch (10 mils) thick.
  - 1. Manufacturers: Subject to compliance with requirements provide products by one of the following:

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- a. Insulation Solutions, Inc.
- b. Raven Industries Inc.
- c. Reef Industries, Inc.

2. Material:

- a. Classification: ASTM E1745 Class C
- b. Puncture Resistance: Greater than 1500 grams per ASTM D1709
- c. Tensile strength:
  - 1) New Material: 32 lbs per inch (56 N/cm) per ASTM E154
  - 2) After soaking: 25 lbs per inch (44 N/cm) per ASTM E154

2.2 ACCESSORIES

- A. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
- B. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.
- C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to vapor retarders, including removing projections capable of puncturing vapor retarders.

3.2 INSTALLATION OF VAPOR RETARDERS ON FRAMING

- A. Place vapor retarders on side of construction indicated on Drawings.
- B. Lap Vapor Barriers seams a minimum of 12" and secure with Vapor Barrier Tape.
- C. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives, vapor retarder fasteners, or other anchorage system as recommended by manufacturer. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
- D. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs and sealing with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Locate all joints over framing members or other solid substrates.

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- E. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders. Vapor Retarder must extend to within 1/2" of any penetration before being sealed with vapor retarder tape.
- F. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

### 3.3 PROTECTION

- A. Protect vapor retarders from damage until concealed by permanent construction.

END OF SECTION 072600

## SECTION 072727 - VAPOR PERMEABLE AIR BARRIERS

### 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 self-adhering, water resistive vapor permeable air barriers.
- B. Related Requirements:
  - 1. Section 061600 "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.

#### 1.3 DEFINITIONS

- A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.
- B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
- C. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include manufacturer's written instructions for evaluating, preparing, and treating each substrate; technical data; and tested physical and performance properties of products.

- B. Shop Drawings: For air-barrier assemblies.
  - 1. Show locations and extent of air barrier materials, accessories, and assemblies specific to Project conditions.
  - 2. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
  - 3. Include details of interfaces with other materials that form part of air barrier.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with air barrier.
- C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.
- D. Field quality-control reports.

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
  - 1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.
- B. Mockups: Build mockups to set quality standards for materials and execution.
  - 1. Build integrated mockups of exterior wall assembly minimum 6 by 6 foot, incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
    - a. Coordinate construction of mockups to permit inspection and testing of air barrier before external insulation and cladding are installed.
    - b. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
    - c. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- B. Protect stored materials from direct sunlight.

#### 1.9 FIELD CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended in writing by air-barrier manufacturer.
  1. Protect substrates from environmental conditions that affect air-barrier performance.
  2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.

#### 2.2 PERFORMANCE REQUIREMENTS

- A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction shall be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

#### 2.3 SELF-ADHERING SHEET AIR BARRIER

- A. Water resistive vapor permeable air barrier for rainscreen systems: Zero VOC self-adhered vapor permeable air barrier sheet membrane consisting of multiple layers of UV stabilized membrane.

### VAPOR PERMEABLE AIR BARRIERS

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1. Basis of design: Subject to compliance with requirements, provide Wrapshield SA manufactured by Vaproshield LLC or comparable products by, but not limited to the following:
  - a. Grace, W. R. & Co., Perm-A-Barrier VPS
  - b. Meadows, W. R., Inc.
2. Physical and Performance Properties:
  - a. Air Leakage: Maximum 0.00003 cfm/sq. ft. @ 1.57 psf when tested in accordance with ASTM E 2178
  - b. Water Vapor Permeance tested to ASTM E 96 Method B: minimum 40 perms
  - c. Water Resistance tested to AATCC 127, 550 mm hydrostatic head for 5 hours: No leakage
  - d. Tensile Strength tested to ASTM D 882: 44.8 lbf/inch (78 N/mm), machine direction; 25 lbf/inch (43.8 N/mm), cross-machine direction
  - e. Application Temperature: Ambient temperature must be above 20 degrees F
  - f. Surface Burning Characteristics tested to ASTM E 84: Class A
  - g. UV Resistance: Can be exposed to sunlight for 180 days according to manufacturer's written instructions.

## 2.4 ACCESSORY MATERIALS

- A. Requirement: Provide primers, transition strips, termination strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.
- B. Vinyl extrusion with pre-formed fastener and moisture drainage channels configured to create a ventilated airspace between wall cladding and weather-resistive air barrier.
- C. Penetration sealant: Provide sealant for penetrations as recommended by manufacturer and as specified under Division 07 Section: Sealants.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
  1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.

## VAPOR PERMEABLE AIR BARRIERS

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2. Verify that substrates have cured and aged for minimum time recommended in writing by air-barrier manufacturer.
  3. Verify that substrates are visibly dry and free of moisture.
  4. Verify that masonry joints are flush and completely filled with mortar.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 SURFACE PREPARATION

- A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate according to manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier 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 other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.
- E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.
- H. Bridge isolation joints, expansion joints and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement according to manufacturer's written instructions and details.

### 3.3 INSTALLATION

- A. Install materials according to air-barrier manufacturer's written instructions and details and according to recommendations in ASTM D 6135 to form a seal with adjacent construction and ensure continuity of air and water barrier.
  1. When ambient and substrate temperatures range between 25 and 40 deg F (minus 4 and plus 5 deg C), install self-adhering, air-barrier sheet produced for low-temperature application. Do not install low-temperature sheet if ambient or substrate temperature is higher than 60 deg F (16 deg C).

2. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
- B. Prepare, treat, and seal inside and outside corners and vertical and horizontal surfaces at terminations and penetrations with termination mastic and according to ASTM D 6135.
- C. Apply and firmly adhere air-barrier sheets over area to receive air barrier. 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 airtight installation.
  1. Apply sheets in a shingled manner to shed water.
  2. Roll sheets firmly to enhance adhesion to substrate.
- D. Apply continuous air-barrier sheets over accessory strips bridging substrate cracks, construction, and contraction joints.
- E. Seal top of through-wall flashings to air-barrier sheet with an additional 6-inch- (150-mm-) wide, transition strip.
- F. Seal exposed edges of sheet at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- G. Install air-barrier sheet and accessory materials to form a seal with adjacent construction and to maintain a continuous air barrier.
  1. Coordinate air-barrier installation with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
  2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate.
- H. Connect and seal exterior wall air-barrier sheet continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- I. At end of each working day, seal top edge of air-barrier material to substrate with termination mastic.
- J. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- K. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of contact over firm bearing to perimeter frames, with not less than 1 inch (25 mm) of full contact.
  1. Transition Strip: Roll firmly to enhance adhesion.

- L. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of air-barrier material with foam sealant.
- M. Repair punctures, voids, and deficient lapped seams in air barrier. Slit and flatten fishmouths and blisters. Patch with air-barrier sheet extending 6 inches (150 mm) beyond repaired areas in all directions.
- N. Do not cover air barrier until it has been tested and inspected by testing agency.
- O. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

### 3.4 FIELD QUALITY CONTROL

- A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
  - 1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
  - 2. Continuous structural support of air-barrier system has been provided.
  - 3. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
  - 4. Site conditions for application temperature and dryness of substrates have been maintained.
  - 5. Maximum exposure time of materials to UV deterioration has not been exceeded.
  - 6. Laps in sheet materials have complied with the minimum requirements and have been shingled in the correct direction (or mastic applied on exposed edges), with no fishmouths.
  - 7. Air barrier has been firmly adhered to substrate.
  - 8. Compatible materials have been used.
  - 9. Transitions at changes in direction and structural support at gaps have been provided.
  - 10. Connections between assemblies (air barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
  - 11. All penetrations have been sealed.
- D. Tests: As determined by testing agency from among the following tests:
  - 1. Air-Leakage-Location Testing: Air-barrier assemblies will be tested for evidence of air leakage according to ASTM E 1186, chamber pressurization or depressurization with smoke tracers or ASTM E 1186, chamber depressurization using detection liquids.

2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate according to ASTM E 783 or ASTM E 2357.
  3. Adhesion Testing: Air-barrier assemblies will be tested for required adhesion to substrate according to ASTM D 4541 for each 600 sq. ft. (56 sq. m) of installed air barrier or part thereof.
- E. Air barriers will be considered defective if they do not pass tests and inspections.
1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
  2. Remove and replace deficient air-barrier components for retesting as specified above.
- F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
- G. Prepare test and inspection reports.

### 3.5 CLEANING AND PROTECTION

- A. Protect wall areas covered with self-adhered water-resistive vapor permeable air barrier from damage due to construction activities, high wind conditions, and extended exposure to inclement weather.
- B. Review condition of self-adhered water-resistive vapor permeable air barrier prior to installation of cladding. Repair, or remove and replace damaged sections with new membrane.
- C. Recommend to cap and protect exposed back-up walls against wet weather conditions during and after application of membrane, including wall openings and construction activity above completed self-adhered water-resistive vapor permeable air barrier installations.
- D. Remove and replace water-resistive weather barrier membrane affected by chemical spills or surfactants.
- E. Clean spills, stains, and soiling from construction that would be exposed in the completed Work, using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 072727

## SECTION 074646 - FIBER-CEMENT SIDING

### 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 fiber-cement siding.
- B. Related Requirements:
  - 1. Section 061053 "Miscellaneous Rough Carpentry" for wood furring, grounds, nailers, and blocking.
  - 2. Section 072100 Thermal Insulation for building insulation.
  - 3. Section 072727 "Vapor Permeable Air Barriers" for weather resistive barriers.

#### 1.3 COORDINATION

- A. Coordinate siding installation with flashings and other adjoining construction to ensure proper sequencing.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at project site.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples for Verification: For each type, color, texture, and pattern required.
  - 1. 12-inch- (300-mm-) long-by-actual-width Sample of siding.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of fiber-cement siding.

## FIBER-CEMENT SIDING

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- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fiber-cement siding.
- C. Sample Warranty: For special warranty.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of product, including related accessories, to include in maintenance manuals.

#### 1.8 QUALITY ASSURANCE

- A. Source Limitations: Obtain texture and pattern of siding including related accessories, from single source from single manufacturer.
- B. Installer Qualifications: A firm that is approved or licensed by manufacturer for installation of cement board required for this Project and is eligible to receive special warranties specified.
  - 1. In continuous business under same name for past five (5) years.
  - 2. Completed at least three (3) successful installations of specified materials and systems on projects of similar scope.
  - 3. Contractor shall provide all personnel trained in application of materials and systems and shall maintain supervision as specified elsewhere.
- C. Installer Field Supervision: Require installer to maintain a full-time supervisor / foreman on the job site during times that siding systems installation is in progress, and who is experienced in installation of the specified systems.
- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
  - 1. Build mockup of typical wall area as shown on Drawings.
  - 2. Build mockups for siding including accessories.
    - a. Size: 48-inches long by 60-inches high, or as practical and authorized by Owner and/or Architect.
    - b. Include outside corner on one end of mockup and inside corner on other end.
  - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner's Representative specifically approves such deviations in writing.  
Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with labels intact until time of use.
- B. Store materials on elevated platforms, under cover, and in a dry location.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including cracking and deforming.
    - b. Deterioration of materials beyond normal weathering.
  - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain products, including related accessories, from single source from single manufacturer.

2.2 FIBER-CEMENT SIDING

- A. General: ASTM C 1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E 136; with a flame-spread index of 25 or less when tested according to ASTM E 84.
- B. Basis-of-Design Products: Subject to compliance with requirements, provide SwissPearl LARGO as distributed by authorized SwissPearl distributor or approved equal.
- C. Labeling: Provide fiber-cement siding that is tested and labeled according to ASTM C 1186 by a qualified testing agency acceptable to authorities having jurisdiction.
- D. Nominal Thickness: Not less than 5/16 inch (8 mm).
- E. Panel strips Size: (2500 x 147mm-) with smooth texture.
- F. Large panel size: 1220mm x 2500mm with smooth texture cut to fit as shown on drawings.
- G. Finish: CARAT. Color Black Opal 7021, field verify to match existing.

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## 2.3 ACCESSORIES

- A. Decorative Accessories: Provide the following fiber-cement decorative accessories as indicated:
- B. Flashing: Provide flashing complying with Section 076200 "Sheet Metal Flashing and Trim", including joint flashing between units of siding.
- C. Fasteners:
  - 1. For fastening fiber cement, use stainless-steel fasteners.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of fiber-cement siding and related accessories.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.

### 3.3 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply. System is open joint with panels attached by face fastened screws.
  - 1. Do not install damaged components.
- B. Install joint sealants as specified in Section 079200 "Joint Sealants" and to produce a weathertight installation.
- C. Comply with requirements as specified in the Section of these specifications that outlines weather barrier. Required behind siding system.

### 3.4 ADJUSTING AND CLEANING

- A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.

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- B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 074646

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## SECTION 075423 - THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

### 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. Adhered thermoplastic polyolefin (TPO) roofing system.
  - 2. Vapor retarder.
  - 3. Roof insulation.

- B. Related Requirements:

- 1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
  - 2. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
  - 3. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

#### 1.3 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project site.
  - 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
  - 2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
  - 3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
- C. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work, including:
1. Base flashings and membrane terminations.
  2. Tapered insulation, including slopes.
  3. Roof plan showing orientation of steel roof deck and orientation of roofing.
  4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
- D. Samples for Verification: For the following products:

1. Sheet roofing, of color required.
2. Walkway pads or rolls, of color required.
3. 4-by-4-inch square of overlay board.
4. 12-inch length of metal termination bars

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
  1. Submit evidence of compliance with performance requirements.
- C. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Research/Evaluation Reports: For components of roofing system, from ICC-ES.
- E. Field quality-control reports.
- F. Sample Warranties: For manufacturer's special warranties.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing system to include in maintenance manuals.

#### 1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is UL listed, FM Global approved for roofing system identical to that used for this Project.
- B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
  1. In continuous business under same name for past 5 years.
  2. Completed at least 3 successful installations of specified materials and systems on projects of similar scope.
  3. Contractor shall provide all personnel trained in application of materials and systems and shall maintain supervision as specified elsewhere.
  4. Installer Field Supervision: Require Installer to maintain a full-time supervisor / foreman on the job site during times that single ply roofing systems installation is in progress, and who is experienced in installation of the specified roofing systems.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
  - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.
- B. Provide tarps or plastic sheeting required to protect opened roofs and flashings and to prevent the entrance of moisture or rain water into the existing structure until new materials have been applied and roof is in a watertight condition.
- C. Have necessary waterproof canvas or plastic sheeting readily available in case of emergency.
- D. Roofing materials shall not be applied when water in any form (i.e., rain, dew, ice, frost, snow, etc.) is present on the deck.
- E. Provide necessary protection over newly installed membrane during the course of construction at all roof access points and at high traffic areas.
- F. Measures to protect the newly installed membrane shall be employed during the entire duration of the work from staining and damage.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty includes roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories and other components of roofing system.
  2. Warranty Period: 20 years from date of Substantial Completion.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, and walkway products, for the following warranty period:
1. Warranty Period: Two years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Must match existing Carlisle FleeceBACK TPO membrane on building. Contractor to field verify.
- B. Source Limitations: Obtain components including roof insulation, fasteners for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.
  1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
  2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.
- B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.
- C. FM Global Listing: Roofing, base flashings, and component materials shall comply with requirements in FM Global 4450 or FM Global 4470 as part of a built-up roofing system, and shall be listed in FM Global's "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
  1. Fire/Windstorm Classification: Class 1A-90.
  2. Hail-Resistance Rating: MH.

- D. Energy Star Listing: Roofing system shall be listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
- E. Energy Performance: Roofing system shall have an initial solar reflectance of not less than 0.70 and an emissivity of not less than 0.75 when tested according to CRRC-1.
- F. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- G. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

## 2.3 TPO ROOFING

- A. Fabric-Reinforced TPO Sheet: ASTM D 6878, internally fabric- or scrim-reinforced, uniform, flexible fleece-backed TPO sheet.
  - 1. Thickness: 60 mils, nominal.
  - 2. Exposed Face Color: White.

## 2.4 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.
  - 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
  - 2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content:
    - a. Plastic Foam Adhesives: 50 g/L.
    - b. Gypsum Board and Panel Adhesives: 50 g/L.
    - c. Multipurpose Construction Adhesives: 70 g/L.
    - d. Fiberglass Adhesives: 80 g/L.
    - e. Single-Ply Roof Membrane Adhesives: 250 g/L.
    - f. Single-Ply Roof Membrane Sealants: 450 g/L.
    - g. Nonmembrane Roof Sealants: 300 g/L.
    - h. Sealant Primers for Nonporous Substrates: 250 g/L.
    - i. Sealant Primers for Porous Substrates: 775 g/L.
    - j. Other Adhesives and Sealants: 250 g/L.
  - 3. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the

Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources  
Using Environmental Chambers."

- B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as TPO sheet.
- C. Bonding Adhesive: Manufacturer's standard.
- D. Slip Sheet: Manufacturer's standard, of thickness required for application.
- E. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
- F. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick), prepunched.
- G. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roofing to substrate, and acceptable to roofing system manufacturer.
- H. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

## 2.5 SUBSTRATE BOARDS

- A. Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch thick.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide DensDeck manufactured by Georgia Pacific, or comparable product by but not limited to one of the following:
    - a. USG.
    - b. Certainteed.
    - c. National Gypsum.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening substrate board to roof deck.

## 2.6 VAPOR RETARDER

- A. Self-Adhering-Sheet Vapor Retarder: ASTM D 1970, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 40-mil- total thickness; maximum permeance rating of 0.1 perm; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

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## 2.7 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by TPO roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Global-approved roof insulation.
- B. Extruded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.5-lb/cu. ft. minimum density, square edged.
- C. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
- D. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope as indicated in drawings unless otherwise indicated.
- E. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

## 2.8 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
  - 1. Modified asphaltic, asbestos-free, cold-applied adhesive.
  - 2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
  - 3. Full-spread spray-applied, low-rise, two-component urethane adhesive.
- D. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch factory primed.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide DensDeck manufactured by Georgia Pacific, or comparable product by but not limited to one of the following:
    - a. USG.
    - b. Certainteed.
    - c. National Gypsum.

## 2.9 ASPHALT MATERIALS

- A. Roofing Asphalt: ASTM D 312, Type III or Type IV.
- B. Asphalt Primer: ASTM D 41/D 41M.

## 2.10 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
  - 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
  - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Install insulation strips according to acoustical roof deck manufacturer's written instructions.

## 3.3 ROOFING INSTALLATION, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

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- C. Install roofing and auxiliary materials to tie in to existing roofing to maintain weather tightness of transition and to not void warranty for existing roofing system.

### 3.4 SUBSTRATE BOARD INSTALLATION

- A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
  - 1. Fasten substrate board to top flanges of steel deck according to recommendations in FM Global's "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
  - 2. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.

### 3.5 VAPOR-RETARDER INSTALLATION

- A. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches (90 mm) and 6 inches (150 mm), respectively. Seal laps by rolling.
- B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

### 3.6 INSULATION INSTALLATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
- E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

- F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
  - 1. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
- G. Mechanically Fastened and Adhered Insulation: Install each layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
  - 1. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
  - 2. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature
- H. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck.
  - 1. Adhere cover boards according to requirements in FM Global's "RoofNav" for specified Windstorm Resistance Classification.
- I. Install slip sheet over cover board and immediately beneath roofing.

### 3.7 ADHERED ROOFING INSTALLATION

- A. Adhere roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll roofing and allow to relax before retaining.
- B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
- C. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Bonding Adhesive: Apply to substrate and underside of roofing at rate required by manufacturer, and allow to partially dry before installing roofing. Do not apply to splice area of roofing.
- E. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeter of roofing.
- F. Apply roofing with side laps shingled with slope of roof deck where possible.
- G. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roofing and sheet flashings according to manufacturer's written instructions, to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet.
  2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
  3. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.
- H. Spread sealant bed over deck-drain flange at roof drains, and securely seal roofing in place with clamping ring.

### 3.8 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

### 3.9 WALKWAY INSTALLATION

- A. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

### 3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish reports to Architect.
- B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
- C. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.11 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075423

## SECTION 076200 - SHEET METAL FLASHING AND TRIM

### 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. Manufactured through-wall flashing with counterflashing.
  - 2. Formed roof-drainage sheet metal fabrications.
  - 3. Formed low-slope roof sheet metal fabrications.
  - 4. Formed wall sheet metal fabrications.
  - 5. Formed equipment support flashing.

- B. Related Requirements:

- 1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
  - 2. Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

#### 1.3 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

- 1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
  - 3. Review requirements for insurance and certificates if applicable.
  - 4. Review sheet metal flashing observation and repair procedures after flashing installation.

## 1.5 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 each manufactured product and accessory.
- B. Sustainable Design Submittals:
- C. Shop Drawings: For sheet metal flashing and trim.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
  - 3. Include identification of material, thickness, weight, and finish for each item and location in Project.
  - 4. Include details for forming, including profiles, shapes, seams, and dimensions.
  - 5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
  - 6. Include details of termination points and assemblies.
  - 7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
  - 8. Include details of roof-penetration flashing.
  - 9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
  - 10. Include details of special conditions.
  - 11. Include details of connections to adjoining work.
  - 12. Detail formed flashing and trim at scale of not less than 3 inches per 12 inches.
- D. Samples for Verification: For each type of exposed finish.
  - 1. Sheet Metal Flashing: 12 inches (300 mm) long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
  - 2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches (300 mm) long and in required profile. Include fasteners and other exposed accessories.
  - 3. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Sample Warranty: For special warranty.

## 1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

## 1.8 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

## 1.10 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

- B. Sheet Metal Standard for Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- D. SPRI Wind Design Standard: Manufacture and install copings and roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:
  - 1. Design Pressure: As indicated on Drawings.

## 2.2 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Stainless-Steel Sheet: ASTM A 240/A 240M, dead soft, fully annealed; with smooth, flat surface.
  - 1. Finish: 2D (dull, cold rolled).
- C. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet according to ASTM A 653/A 653M, G90 (Z275) coating designation or aluminum-zinc alloy-coated steel sheet according to ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation, Grade 40 (Grade 275); prepainted by coil-coating process to comply with ASTM A 755/A 755M.
  - 1. Surface: Smooth, flat.
  - 2. Exposed Coil-Coated Finish:
    - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 3. Color: As selected by Architect from manufacturer's full range.
  - 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).

## 2.3 UNDERLAYMENT MATERIALS

- A. Felt: ASTM D 226/D 226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.
- B. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over 220 deg F (111 deg C); and complying with physical requirements of ASTM D 226/D 226M for Type I and Type II felts.
- C. Self-Adhering, High-Temperature Sheet: Minimum 30 mils (0.76 mm) thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer.
  - 1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C) or higher.
  - 2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C) or lower.
- D. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum.

## 2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
  - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
    - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
    - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
  - 2. Fasteners for Zinc-Coated (Galvanized), Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

- C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
- D. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- F. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- G. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.
- H. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

## 2.5 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
  - 1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
  - 2. Obtain field measurements for accurate fit before shop fabrication.
  - 3. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
  - 4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
  - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
  - 2. Use lapped expansion joints only where indicated on Drawings.

- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
- G. Do not use graphite pencils to mark metal surfaces.

## 2.6 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Roof Edge Flashing and Fascia Cap: Fabricate in minimum 96-inch long, but not exceeding 12-foot- (3.6-m-) long sections. Furnish with 6-inch wide, joint cover plates. Shop fabricate interior and exterior corners.
  - 1. Joint Style: Standing seam with 45 degree slope at all faces of coping visible from below.
  - 2. Fabricate from the Following Materials:
    - a. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.
- B. Copings: Fabricate in minimum 96-inch long, but not exceeding 12-foot long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and interior leg. Miter corners, fasten and seal watertight. Shop fabricate interior and exterior corners.
  - 1. Joint Style: Butted with expansion space and 6-inch- wide, concealed backup plate.
  - 2. Fabricate from the Following Materials:
    - a. Aluminum-Zinc Alloy-Coated Steel: 0.040 inch thick.
- C. Base Flashing: Fabricate from the following materials:
  - 1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.
- D. Counterflashing: Fabricate from the following materials:
  - 1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.
- E. Flashing Receivers: Fabricate from the following materials:
  - 1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.
- F. Roof-Penetration Flashing: Fabricate from the following materials:
  - 1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

G. Roof-Drain Flashing: Fabricate from the following materials:

1. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch thick.

2.7 WALL SHEET METAL FABRICATIONS

A. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch- (50-mm-) high, end dams. Fabricate from the following materials:

1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

2.8 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following materials:

1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

PART 3 - EXECUTION

3.1 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.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Prime substrate if recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps and edges with roller. Cover underlayment within 14 days.

### 3.3 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
  - 1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
  - 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
  - 3. Space cleats not more than 12 inches (300 mm) apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
  - 4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
  - 5. Torch cutting of sheet metal flashing and trim is not permitted.
  - 6. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
  - 1. Coat concealed side of stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
  - 2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches (600 mm) of corner or intersection.
  - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
  - 2. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
  2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets with solder to width of 1-1/2 inches (38 mm); however, reduce pre-tinning where pre-tinned surface would show in completed Work.
1. Stainless-Steel Soldering: Tin edges of uncoated sheets, using solder for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

### 3.4 ROOF-DRAINAGE SYSTEM INSTALLATION

- A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Parapet Scuppers: Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
  1. Loosely lock front edge of scupper with conductor head.

### 3.5 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.
- C. Copings: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated.
  1. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24-inch centers.

- D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches (100 mm) over base flashing. Install stainless-steel draw band and tighten.
- E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches (100 mm) over base flashing. Lap counterflashing joints minimum of 4 inches (100 mm). Secure in waterproof manner by means of snap-in installation and sealant or lead wedges and sealant unless otherwise indicated.
- F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

### 3.6 WALL FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

### 3.7 MISCELLANEOUS FLASHING INSTALLATION

- A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

### 3.8 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
- B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

### 3.9 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.
- D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.
- E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200

## SECTION 077200 - ROOF ACCESSORIES

### 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. Roof hatches.

- B. Related Sections:

- 1. Section 055000 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
  - 2. Section 055213 "Pipe and Tube Railings" for safety railing systems not attached to roof-hatch curbs.
  - 3. Section 076200 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.
  - 4. Section 230548 "Vibration and Seismic Controls for HVAC" for special curbs designed to accommodate seismic and vibration controls.
  - 5. Section 233423 "HVAC Power Ventilators" for power roof-mounted ventilators.
  - 6. Section 237413 "Packaged, Outdoor, Central-Station Air-Handling Units" for standard curbs specified with rooftop units.

#### 1.3 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leak proof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

## 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

### 2.2 ROOF HATCH

- A. Roof Hatches: Metal roof-hatch units with lids and insulated curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, and integrally formed deck-mounting flange at perimeter bottom.
  1. Subject to compliance with requirements, provide Bilco with LadderUp Safety Post.
- B. Type and Size: Single-leaf lid, size as indicated in drawings.
- C. Loads: Minimum 40-lbf/sq. ft. external live load and 20-lbf/sq. ft. internal uplift load.
- D. Hatch Material: Aluminum sheet.
  1. Thickness: Manufacturer's standard thickness for hatch size indicated.
  2. Finish: Mill.
- E. Construction:
  1. Insulation: Manufacturer's standard.
  2. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
  3. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
  4. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
  5. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
  6. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter

curb are level. Equip hatch with water diverter or cricket on side that obstructs water flow.

- F. Hardware: Spring operators, hold-open arm, stainless-steel spring latch with turn handles, stainless-steel butt- or pintle-type hinge system, and padlock hasps inside and outside.
- G. Safety Railing System: Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.
  - 1. Manufacturer: Bilco Bil-Guard
  - 2. Height: 42 inches above finished roof deck.
  - 3. Posts and Rails: Fiberglass reinforced polymer.
  - 4. Maximum Opening Size: System constructed to prevent passage of a sphere 21 inches (533 mm) in diameter.
  - 5. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
  - 6. Fasteners: Manufacturer's standard, finished to match railing system.
  - 7. Finish: Manufacturer's standard.

## 2.3 METAL MATERIALS

- A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
  - 1. Mill Finish: As manufactured.
  - 2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil (0.013 mm).
- B. Aluminum Extrusions and Tubes: ASTM B 221 (ASTM B 221M), manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.
- C. Stainless-Steel Sheet and Shapes: ASTM A 240/A 240M or ASTM A 666, Type 304.

## 2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- 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.

## ROOF ACCESSORIES

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## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions.
  - 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
  - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
  - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
  - 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
  - 1. Coat concealed side of uncoated aluminum and stainless-steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
  - 2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
  - 3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. Roof-Hatch Installation:
  - 1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
  - 2. Attach safety railing system to roof-hatch curb.
  - 3. Attach ladder-assist post according to manufacturer's written instructions.
- D. Seal joints with elastomeric sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

- A. Clean exposed surfaces according to manufacturer's written instructions.
- B. Clean off excess sealants.
- C. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

## SECTION 078413 - PENETRATION FIRESTOPPING

### 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. Penetrations in fire-resistance-rated walls.
  - 2. Penetrations in horizontal assemblies.
  - 3. Penetrations in smoke barriers.

- B. Related Requirements:

- 1. Section 078443 "Joint Firestopping" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
  - 1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
  - 2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
    - a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.
      - 1) UL in its "Fire Resistance Directory."
      - 2) Intertek Group in its "Directory of Listed Building Products."
      - 3) FM Global in its "Building Materials Approval Guide."

## 2.2 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. A/DFireProtectionSystemsInc.
    - b. GraceConstructionProducts.
    - c. Hilti, Inc.
    - d. Johns Manville.
    - e. Nelson Firestop Products.
    - f. NUCO Inc.
    - g. Passive Fire Protection Partners.
    - h. RectorSeal Corporation.
    - i. Specified Technologies Inc.
    - j. 3M Fire Protection Products.
    - k. Tremco, Inc.; Tremco Fire Protection Systems Group.
- B. USGCorporation Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
  2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
  3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.
- D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg (74.7 Pa).
1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at and no more than 50-cfm (0.024-cu. m/s) cumulative total for any 100 sq. ft. (9.3 sq. m) at both ambient and elevated temperatures.

- E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.
- F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
  - 1. Permanent forming/damming/backing materials.
  - 2. Substrate primers.
  - 3. Collars.
  - 4. Steel sleeves.

## 2.3 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

## 2.4 MIXING

- A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:
  - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
  - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
  - 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

### 3.3 INSTALLATION

- A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- C. Install fill materials by proven techniques to produce the following results:
  1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
  2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

### 3.4 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.
  1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).
- B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
  1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
  2. Contractor's name, address, and phone number.
  3. Designation of applicable testing and inspecting agency.
  4. Date of installation.
  5. Manufacturer's name.
  6. Installer's name.

### 3.5 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out

and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

### 3.6 PENETRATION FIRESTOPPING SYSTEM SCHEDULE

- A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.
- B. Where Intertek Group-listed systems are indicated, they refer to design numbers in Intertek Group's "Directory of Listed Building Products" under "Firestop Systems."
- C. Where FM Global-approved systems are indicated, they refer to design numbers listed in FM Global's "Building Materials Approval Guide" under "Wall and Floor Penetration Fire Stops."
- D. Firestop Systems with No Penetrating Items : Comply with the following:
  - 1. Available UL-Classified Systems: C-AJ-, C-BJ, F-A- or W-L- 0001-0999.
- E. Firestop Systems for Metallic Pipes, Conduit, or Tubing Comply with the following:
  - 1. Available UL-Classified Systems: C-AJ-, F-A-, F-C-, W-J-, or W-L- 1001-1999.
- F. Firestop Systems for Nonmetallic Pipe, Conduit, or Tubing : Comply with the following:
  - 1. Available UL-Classified Systems: C-AJ-, F-A-, F-C- or W-L- 2001-2999.
- G. Firestop Systems for Electrical Cables : Comply with the following:
  - 1. Available UL-Classified Systems: C-AJ-, C-BJ-, F-A-, F-C-, or W-L- 3001-3999.
- H. Firestop Systems for Cable Trays: Comply with the following:
  - 1. Available UL-Classified Systems: C-AJ-, C-BJ-, or W-L- 4001-4999.
- I. Firestop Systems for Insulated Pipes : Comply with the following:
  - 1. Available UL-Classified Systems: C-AJ-, C-BJ-, F-A-, F-C- 5001-5999.
- J. Firestop Systems for Miscellaneous Electrical Penetrants: Comply with the following:
  - 1. Available UL-Classified Systems: C-AJ-, or F-A-6001-6999.
- K. Firestop Systems for Miscellaneous Mechanical Penetrations: Comply with the following:
  - 1. Available UL-Classified Systems: C-AJ-7001-7999.
- L. Firestop Systems for Groupings of Penetrations: Comply with the following:

1. Available UL-Classified Systems: C-AJ-, C-BJ-, F-A-, or W-L-8001-8999.

END OF SECTION 078413

## SECTION 078443 - JOINT FIRESTOPPING

### 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. Joints in or between fire-resistance-rated constructions.
  - 2. Joints at exterior curtain-wall/floor intersections.
  - 3. Joints in smoke barriers.

- B. Related Requirements:

- 1. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers and for wall identification.
  - 2. Section 092216 "Non-Structural Metal Framing" for firestop tracks for metal-framed partition heads.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

- 1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

## 1.5 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

## 1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

## 1.8 COORDINATION

- A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of joints to accommodate joint firestopping systems.

# PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
  - 1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
  - 2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:
    - a. Joint firestopping systems shall bear classification marking of a qualified testing agency.
      - 1) UL in its "Fire Resistance Directory."
      - 2) Intertek Group in its "Directory of Listed Building Products."

## 2.2 JOINT FIRESTOPPING SYSTEMS

- A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E 1966 or UL 2079.
  - 1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.
- C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide joint firestopping systems with rating determined per ASTM E 2307.
  - 1. F-Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
- D. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079 based on testing at a positive pressure differential of 0.30-inch wg (74.7 Pa).
  - 1. L-Rating: Not exceeding 5.0 cfm/ft. (0.00775 cu. m/s x m) of joint at both ambient and elevated temperatures.
- E. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- F. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Cleaning: Before installing fire-resistive joint systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
  - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
  - 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
  - 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

### 3.3 INSTALLATION

- A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
  - 1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install elastomeric fill materials for fire-resistive joint systems by proven techniques to produce the following results:
  - 1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
  - 2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
  - 3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

### 3.4 IDENTIFICATION

- A. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

### 3.5 FIELD QUALITY CONTROL

- A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2393.
- B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.
- C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

### 3.6 CLEANING AND PROTECTION

- A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.
- B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION 078443

## SECTION 079200 - 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:
  - 1. Silicone joint sealants.
  - 2. Urethane joint sealants.
  - 3. Mildew-resistant joint sealants.
  - 4. Latex joint sealants.
  - 5. Low expanding foam sealant.

#### 1.3 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product.
- B. Joint-Sealant Schedule: Include the following information:
  - 1. Joint-sealant application, joint location, and designation.
  - 2. Joint-sealant manufacturer and product name.
  - 3. Joint-sealant formulation.
  - 4. Joint-sealant color.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Product Test Reports: For each kind of joint sealant, for tests performed by a qualified testing agency.
- C. Field-Adhesion-Test Reports: For each sealant application tested.

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- D. Sample Warranties: For special warranties.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.
1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

## 1.7 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## 1.8 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.
- B. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

## PART 2 - PRODUCTS

### 2.1 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

### 2.2 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 50, NT: Single-component, non-sag, plus 50 percent and minus 50 percent movement capability, non-traffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
  - 1. Manufacturers: Subject to compliance with requirements, provide Dow Corning 795 or comparable products from, but not limited to, the following:
    - a. GE Advanced materials
    - b. May National Associates, Inc.
    - c. Tremco, Inc.
  - 2. Location: Exterior non paintable surfaces

### 2.3 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 100/50, T, NT: Single-component, non-sag, plus 100 percent and minus 50 percent movement capability, traffic- and non-traffic-use, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Uses T, NT, M, A, O and I (Class 2)
  - 1. Manufacturers: Subject to compliance with requirements, provide Vulkem 921 or comparable products from, but not limited to, the following:
    - a. BASF Building Systems
    - b. Bostik, Inc.
    - c. Sika Corporation
  - 2. Location:
    - a. At paintable surfaces.
    - b. Slab-on-grade cracks.
    - c. Slab-on-grade joints.

## 2.4 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, non-sag, plus 25 percent and minus 25 percent movement capability, non-traffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
  - 1. Location: At joints in ceramic tile walls and floor, around equipment and around plumbing fixtures.

## 2.5 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
- B. Location: At interior frames/walls.

## 2.6 LOW EXPANDING FOAM SEALANTS

- A. Low expanding, one-component, polyurethane foam sealant, curing to a semi-rigid, closed cell urethane foam. Apply between top of precast concrete panels and metal framing.
- B. Acceptable products:
  - 1. Hilti CF812 WD (Low Pressure polyurethane)
  - 2. Dow GREAT STUFF

## 2.7 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Non-staining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type O (open-cell material), Type B (bi-cellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

## 2.8 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. 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 to joint substrates.
- C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
  - 2. Clean porous joint substrate surfaces by brushing, grinding, 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 after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
    - a. Concrete.
    - b. Masonry.
    - c. Unglazed surfaces of ceramic tile.
    - d. Exterior insulation and finish systems.
  - 3. Remove laitance and form-release agents from concrete.

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4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
  - a. Metal.
  - b. Glass.
  - c. Porcelain enamel.
  - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior 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 or primer 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.

### 3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  1. Do not leave gaps between ends of sealant backings.
  2. Do not stretch, twist, puncture, or tear sealant backings.
  3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
  1. Place sealants so they directly contact and fully wet joint substrates.
  2. Completely fill recesses in each joint configuration.
  3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

- F. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

### 3.4 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:
  - a. Perform 10 tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.
  - b. Perform one test for each 1000 feet (300 m) of joint length thereafter or one test 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.
  - a. 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 complies with sealant manufacturer's 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 material, 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 that original sealant surfaces are clean and that new sealant contacts original sealant.

- B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other 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.

### 3.5 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

### 3.6 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079200

## SECTION 081113 - 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 Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes hollow-metal work.
- B. Related Requirements:
  - 1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

#### 1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

#### 1.4 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

#### 1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, temperature-rise ratings, and finishes.
- B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.

C. Samples for Verification:

1. For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 127 mm).
2. For "Doors" and "Frames" subparagraphs below, prepare Samples approximately 12 by 12 inches (305 by 305 mm) to demonstrate compliance with requirements for quality of materials and construction:
  - a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
  - b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.

D. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.7 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.
  1. Provide compliance with the test procedure standards listed in TABLE 502.4.3 (OEESC).
- B. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
  1. Provide additional protection to prevent damage to factory-finished units.

- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch- (102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Provide Curries 747 T metal doors with metal frames designed for Curries 747 T doors.
- B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

### 2.2 REGULATORY REQUIREMENTS

- A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
  - 1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
- B. Fire-Rated, Borrowed-Lite Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.
- C. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.70 deg Btu/F x h x sq. ft. when tested according to ASTM C 518.

### 2.3 INTERIOR DOORS AND FRAMES

- A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2.
  - 1. Physical Performance: Level B according to SDI A250.4.
  - 2. Doors:

## HOLLOW METAL DOORS AND FRAMES

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- a. Type: As indicated in the Door and Frame Schedule.
  - b. Thickness: 1-3/4 inches (44.5 mm).
  - c. Face: Uncoated, cold-rolled steel sheet, minimum thickness of 0.042 inch (1.0 mm).
  - d. Edge Construction: Model 2, Seamless.
3. Core: Manufacturer's standard.
  4. Frames:
    - a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
    - b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
    - c. Construction: Full profile welded.
  5. Exposed Finish: Prime Factory.

## 2.4 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

- A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2.
  1. Physical Performance: Level B according to SDI A250.4.
  2. Doors:
    - a. Type: As indicated in the Door and Frame Schedule.
    - b. Thickness: 1-3/4 inches (44.5 mm.)
    - c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch (1.0 mm), with minimum A40 (ZF120) coating.
    - d. Edge Construction: Model 2, Seamless.
    - e. Core: Manufacturer's standard.
  3. Frames:
    - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A40 (ZF120) coating.
    - b. Construction: Full profile welded.
  4. Exposed Finish: Prime Factory.

## 2.5 FRAME ANCHORS

- A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (51 mm) wide by 10 inches (254 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.
  2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (1.0 mm) thick.
  3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
  4. Post installed Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-(9.5-mm-) diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
- B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch (1.0 mm), and as follows:
1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
  2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at finish floor surface.

## 2.6 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
- D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.
  1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- G. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.
- H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-

developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

- I. Glazing: Comply with requirements in Section 088000 "Glazing."
- J. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

## 2.7 FABRICATION

- A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Hollow-Metal Doors:
  - 1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch (0.66 mm), steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches (152 mm) apart. Spot weld to face sheets no more than 5 inches (127 mm) o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
  - 2. Fire Door Cores: As required to provide fire-protection and temperature-rise ratings indicated.
  - 3. Vertical Edges for Single-Acting Doors: Provide beveled or square edges at manufacturer's discretion.
  - 4. Top Edge Closures: Close top edges of doors with inverted closures, except provide flush closures at exterior doors of same material as face sheets.
  - 5. Bottom Edge Closures: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets.
  - 6. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
  - 7. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
  - 1. Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
  - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
5. Jamb Anchors: Provide number and spacing of anchors as follows:
  - a. Masonry Type: Locate anchors not more than 16 inches (406 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c., to match coursing, and as follows:
    - 1) Two anchors per jamb up to 60 inches (1524 mm) high.
    - 2) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
    - 3) Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.
    - 4) Four anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high.
  - b. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
    - 1) Three anchors per jamb up to 60 inches (1524 mm) high.
    - 2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
    - 3) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
    - 4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.
  - c. Compression Type: Not less than two anchors in each frame.
  - d. Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.
6. Head Anchors: Two anchors per head for frames more than 42 inches (1067 mm) wide and mounted in metal-stud partitions.
7. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
  - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
  - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
8. Terminated Stops: Terminate stops 6 inches (152 mm) above finish floor with a 45 or 90-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.

- E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
  - 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
  - 2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.
- F. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
  - 1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
  - 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
  - 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
  - 4. Provide loose stops and moldings on inside of hollow-metal work.
  - 5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

## 2.8 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
  - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
- B. Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat.

## 2.9 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick.

## PART 3 - EXECUTION

### 3.1 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 embedded and built-in anchors to verify actual locations before frame installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

### 3.3 INSTALLATION

- A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.
- B. Hollow-Metal Frames: Install hollow-metal frames for doors, transoms, sidelites, borrowed lites, and other openings, of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.
  - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
    - a. At fire-rated openings, install frames according to NFPA 80.
    - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    - c. Install frames with removable stops located on secure side of opening.
    - d. Install door silencers in frames before grouting.
    - e. Remove temporary braces necessary for installation only after frames have been properly set and secured.

- f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    - g. Field apply bituminous coating to backs of frames that will be filled with grout containing anti-freezing agents.
  2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post installed expansion anchors.
    - a. Floor anchors may be set with power-actuated fasteners instead of post installed expansion anchors if so indicated and approved on Shop Drawings.
  3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
  4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
  5. Concrete Walls: Solidly fill space between frames and concrete with mineral-fiber insulation.
  6. In-Place Concrete or Masonry Construction: Secure frames in place with post installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
  7. In-Place Metal or Wood-Stud Partitions: Secure slip-on drywall frames in place according to manufacturer's written instructions.
  8. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
    - a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    - b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
    - c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    - d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.
- C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.
  1. Non-Fire-Rated Steel Doors:
    - a. Between Door and Frame Jambs and Head: 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).
    - b. Between Edges of Pairs of Doors: 1/8 inch (3.2 mm) to 1/4 inch (6.3 mm) plus or minus 1/32 inch (0.8 mm).
    - c. At Bottom of Door: 5/8 inch (15.8 mm) plus or minus 1/32 inch (0.8 mm).
    - d. Between Door Face and Stop: 1/16 inch (1.6 mm) to 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).
  2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
  3. Smoke-Control Doors: Install doors and gaskets according to NFPA 105.

- D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.
  - 1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

### 3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow-metal work immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- E. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

## SECTION 081416 - FLUSH WOOD DOORS

### 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. Solid-core doors with wood-veneer faces.
  - 2. Factory finishing flush wood doors.
- B. Related Requirements:
  - 1. Section 088000 "Glazing" for glass view panels in flush wood doors.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of door. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:
  - 1. Dimensions and locations of blocking.
  - 2. Dimensions and locations of mortises and holes for hardware.
  - 3. Dimensions and locations of cutouts.
  - 4. Undercuts.
  - 5. Requirements for veneer matching.
  - 6. Doors to be factory finished and finish requirements.
  - 7. Fire-protection ratings for fire-rated doors.
- C. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches (200 by 250 mm), for each material and finish.
2. Corner sections of doors, approximately 8 by 10 inches (200 by 250 mm), with door faces and edges representing actual materials to be used.
  - a. Provide Samples for each species of veneer and solid lumber required.
  - b. Provide Samples for each color, texture, and pattern of plastic laminate required.
  - c. Finish veneer-faced door Samples with same materials proposed for factory-finished doors.
3. Frames for light openings, 6 inches (150 mm) long, for each material, type, and finish required.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.
- B. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in plastic bags or cardboard cartons.
- C. Mark each door on butt side of door with opening number used on Shop Drawings.

#### 1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

#### 1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
  1. Failures include, but are not limited to, the following:
    - a. Warping (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section.
    - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm in a 76.2-mm) span.

2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
3. Warranty Period for Solid-Core Exterior Doors: Five years from date of Substantial Completion.
4. Warranty Period for Solid-Core Interior Doors: Life of installation.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide Eggers 5-Ply SCL or comparable products from, but not limited to, the following:
  1. Algoma Hardwoods, Inc.
  2. Graham Wood Doors; an Assa Abloy Group company.
  3. Ideal Wood Products, Inc.
  4. VT Industries Inc.
  5. Weyerhaeuser Company.
  6. Oregon Door.
- B. Source Limitations: Obtain flush wood doors from single manufacturer.

### 2.2 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."
  1. Provide AWI Quality Certification Labels indicating that doors comply with requirements of grades specified.
  2. Contract Documents contain selections chosen from options in quality standard and additional requirements beyond those of quality standard. Comply with those selections and requirements in addition to quality standard.
- B. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.
- C. Structural-Composite-Lumber-Core Doors:
  1. Structural Composite Lumber: WDMA I.S.10.
    - a. Screw Withdrawal, Face: 700 lbf (3100 N).
    - b. Screw Withdrawal, Edge: 400 lbf (1780 N).

## 2.3 VENEER-FACED DOORS FOR TRANSPARENT FINISH

### A. Interior Solid-Core Doors:

1. Grade: Premium, with Grade A faces.
2. Species: White Maple.
3. Cut: Plain sliced (flat sliced).
4. Match between Veneer Leaves: Slip match.
5. Assembly of Veneer Leaves on Door Faces: Balance match.
6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
7. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.
8. Exposed Vertical and Top Edges: Same species as faces - edge Type A.
9. Core: Structural composite lumber.
10. Construction: Five plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering.
11. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.
12. STC Rating: As indicated

## 2.4 LIGHT FRAMES AND LOUVERS

### A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.

1. Wood Species: Same species as door faces.
2. Profile: Flush rectangular beads.
3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.

## 2.5 FABRICATION

### A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.

1. Comply with NFPA 80 requirements for fire-rated doors.

### B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.

1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

- C. Openings: Factory cut and trim openings through doors.
  - 1. Light Openings: Trim openings with moldings of material and profile indicated.
  - 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."

## 2.6 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
  - 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Transparent Finish:
  - 1. Grade: Premium.
  - 2. Finish: AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" System 11, catalyzed polyurethane.
  - 3. Sheen: Satin.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
  - 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
  - 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Hardware: For installation, see Section 087100 "Door Hardware"
- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
  - 1. Install fire-rated doors according to NFPA 80.
  - 2. Install smoke- and draft-control doors according to NFPA 105.

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- C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
  - 1. Clearances: Provide 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors. Provide 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold unless otherwise indicated.
    - a. Comply with NFPA 80 for fire-rated doors.
    - b. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.
  - 2. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock edge; trim stiles and rails only to extent permitted by labeling agency.
- D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

### 3.3 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

## SECTION 083113 - 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.

#### 1.2 SUMMARY

- A. Section includes access doors and frames for walls and ceilings.
- B. Related Requirements:
  - 1. Section 077200 "Roof Accessories" for roof hatches.
  - 2. Section 233330 "Air Duct Accessories" for heating and air-conditioning duct access doors.

#### 1.3 ALLOWANCES

- A. Access doors and frames are part of an access door and frame allowance.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details material descriptions, dimensions of individual components and profiles, and finishes.
- B. Product Schedule: For access doors and frames.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, according to NFPA 252 or UL 10B.

## 2.2 ACCESS DOORS AND FRAMES

### A. Flush Access Doors with Concealed 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. Acudor Products, Inc.
  - b. Babco-Davis; A Cierra Products Co.
  - c. Elmdor/Stoneman; Div. of Acorn Engineering Co.
  - d. Karp Associates, Inc.
2. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
3. Locations: Wall and ceiling.
4. Door Size: 12x12 minimum
5. Uncoated Steel Sheet for Door: Nominal 0.060 inch (1.52 mm), 16 gage, factory primed.
6. Frame Material: Same material and thickness as door.
7. Latch and Lock: As indicated in schedule.

## 2.3 FIRE-RATED ACCESS DOORS AND FRAMES

### A. Fire-Rated, Flush Access Doors with Exposed 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. Acudor Products, Inc.
  - b. Babco-Davis; A Cierra Products Co.
  - c. Elmdor/Stoneman; Div. of Acorn Engineering Co.
  - d. Karp Associates, Inc.
2. Description: Door face flush with frame, with a core of mineral-fiber insulation enclosed in sheet metal; with exposed flange, self-closing door, and concealed hinge.
3. Locations: Wall and ceiling.
4. Door Size: 12x12 minimum.
5. Fire-Resistance Rating: Not less than that of adjacent construction.
6. Uncoated Steel Sheet for Door: Nominal 0.036 inch (0.91 mm), 20 gage, factory primed.
7. Frame Material: Same material, thickness, and finish as door.
8. Latch and Lock: Self-latching door hardware, as indicated in schedule.

### B. Fire-Rated, Flush Access Doors with Concealed 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. Acudor Products, Inc.
  - b. Babco-Davis; A Cierra Products Co.
  - c. Elmdor/Stoneman; Div. of Acorn Engineering Co.
  - d. Karp Associates, Inc.
2. Description: Door face flush with frame, with a core of mineral-fiber insulation enclosed in sheet metal; with concealed flange for gypsum board installation, self-closing door, and concealed hinge.
  3. Locations: Wall and ceiling.
  4. Door Size: 12x12 minimum.
  5. Fire-Resistance Rating: Not less than that of adjacent construction.
  6. Uncoated Steel Sheet for Door: Nominal 0.036 inch (0.91 mm), 20 gage, factory primed.
  7. Frame Material: Same material, thickness, and finish as door.
  8. Latch and Lock: Self-closing, self-latching door hardware, as indicated in schedule.

## 2.4 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- C. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063.
- D. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- E. Frame Anchors: Same material as door face.
- F. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

## 2.5 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.

1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.

D. Latch and Lock Hardware:

1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
2. Keys: Furnish two keys per lock and key all locks alike.
3. Provide Olympus National lock sets 100-200 series

E. Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.6 FINISHES

- A. Comply with NAAMM's "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 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.
- D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
  1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.

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3.3 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083113

## SECTION 084113 - 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 Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Exterior storefront framing.
  - 2. Exterior manual-swing entrance doors and door-frame units.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
  - 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
  - 2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
    - a. Joinery, including concealed welds.
    - b. Anchorage.
    - c. Expansion provisions.
    - d. Glazing.
    - e. Flashing and drainage.
  - 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

- C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- D. Entrance Door Hardware Schedule: Prepared by or under 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.
- E. Delegated-Design Submittal: For aluminum-framed entrances and storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by a qualified testing agency.
- C. Field quality-control reports.
- D. Sample Warranties: For special warranties.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

#### 1.8 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace components of aluminum-framed entrances and storefronts 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 created by wind and thermal and structural movements.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

- d. Water penetration through fixed glazing and framing areas.
  - e. Failure of operating components.
- 2. Warranty Period: Five years from date of Substantial Completion.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.
- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
  - 1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
  - 2. Failure also includes the following:
    - a. Thermal stresses transferring to building structure.
    - b. Glass breakage.
    - c. Noise or vibration created by wind and thermal and structural movements.
    - d. Loosening or weakening of fasteners, attachments, and other components.
    - e. Failure of operating units.
- C. Structural Loads:
  - 1. Wind Loads: As indicated on Drawings.
- D. Deflection of Framing Members: At design wind pressure, as follows:

## ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

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1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.
  2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm).
- E. Structural: Test according to ASTM E 330 as follows:
1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
  2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
  3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
1. Fixed Framing and Glass Area:
    - a. Maximum air leakage of 0.06 cfm/sq. ft. (0.30 L/s per sq. m) at a static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa).
  2. Entrance Doors:
    - a. Pair of Doors: Maximum air leakage of 1.0 cfm/sq. ft. (5.08 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
    - b. Single Doors: Maximum air leakage of 0.5 cfm/sq. ft. (2.54 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
- G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 8.00 lbf/sq. ft. (300 Pa).
- H. Seismic Performance: Aluminum-framed entrances and storefronts shall withstand the effects of earthquake motions determined according to ASCE/SEI 7
- I. Energy Performance: Certify and label energy performance according to NFRC as follows:
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K) as determined according to NFRC 100.

2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.40 as determined according to NFRC 200.
  3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 35 as determined according to NFRC 500.
- J. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
  2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
    - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
    - b. Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).
    - c. Interior Ambient-Air Temperature: 75 deg F (24 deg C).

## 2.2 MANUFACTURERS

- A. Basis-of-Design Products: Subject to compliance with requirements, provide Kawneer VG 451T for storefront and Kawneer insulclad 360 for entrance doors or comparable product by, but not limited to, one of the following:
1. EFCO.
  2. TRACO.
  3. YKK AP America Inc.
- B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

## 2.3 FRAMING

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Thermally broken.
  2. Glazing System: Retained mechanically with gaskets on four sides.
  3. Glazing Plane: As indicated.
  4. Finish: High-performance organic finish.
  5. Fabrication Method: Field-fabricated stick system.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Materials:
  - 1. Aluminum: 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/B 429M.
    - d. Structural Profiles: ASTM B 308/B 308M.
  - 2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
    - a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
    - b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
    - c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

## 2.4 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
  - 1. Door Construction: 2- to 2-1/4-inch (50.8- to 57.2-mm) overall thickness, with minimum 0.125-inch- (3.2-mm-) thick, thermally broken extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
  - 2. Door Design: Wide stile; 5-inch nominal width. 12-inch bottom stile at kickplate location.
  - 3. Glazing Stops and Gaskets: snap-on, extruded-aluminum stops and preformed gaskets.

## 2.5 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 087100 "Door Hardware."
- B. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule for each entrance door to comply with requirements in this Section.
  - 1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products complying with BHMA standard referenced.
  - 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

3. Opening-Force Requirements:
  - a. Egress Doors: Not more than 8 ½ lbf (37.8 N) to fully open door.
  - b. Accessible Interior Doors: Not more than 5 lbf (22.2 N) to fully open door.
- C. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article. Products are identified by using entrance door hardware designations as follows:
  1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in "Entrance Door Hardware Sets" Article.
  2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.
- D. Butt Hinges: BHMA A156.1, Grade 1, radius corner.
  1. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while entrance door is closed.
  2. Exterior Hinges: Nonferrous.
  3. Quantities:
    - a. For doors up to 87 inches (2210 mm) high, provide three hinges per leaf.
    - b. For doors more than 87 and up to 120 inches (2210 and up to 3048 mm) high, provide four hinges per leaf.
- E. Panic Exit Devices: BHMA A156.3, Grade 1, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
- F. Cylinders: BHMA A156.5, Grade 1.
  1. Keying: Master key system. Permanently inscribe each key with a visual key control number and include notation "DO NOT DUPLICATE".
- G. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.
- H. Operating Trim: BHMA A156.6.
- I. Removable Mullions: BHMA A156.3, extruded aluminum.
  1. When used with panic exit devices, provide removable mullions listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305. Use only mullions that have been tested with exit devices to be used.

- J. Closers: BHMA A156.4, Grade 1, with accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use; adjustable to comply with field conditions and requirements for opening force.
- K. Concealed Overhead Holders: BHMA A156.8, Grade 1.
- L. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.
- M. Weather Stripping: Manufacturer's standard replaceable components.
  - 1. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
  - 2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
- N. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.
- O. Silencers: BHMA A156.16, Grade 1.
- P. Thresholds: BHMA A156.21, raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch (12.7 mm).
- Q. Finger Guards: Manufacturer's standard collapsible neoprene or PVC gasket anchored to frame hinge-jamb at center-pivoted doors.

## 2.6 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.

## 2.7 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard 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. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
  - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. 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.

## 2.8 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
  - 1. Profiles that are sharp, straight, and free of defects or deformations.
  - 2. Accurately fitted joints with ends coped or mitered.
  - 3. Physical and thermal isolation of glazing from framing members.
  - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
  - 5. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing or metal panels.
  - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
  - 1. At exterior doors, provide compression weather stripping at fixed stops.
  - 2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
- F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
  2. At exterior doors, provide weather sweeps applied to door bottoms.
- G. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

## 2.9 ALUMINUM FINISHES

- A. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1. Color and Gloss: As selected by Architect from manufacturer's full range.

## 2.10 SOURCE QUALITY CONTROL

- A. Structural Sealant: Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

- A. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

### 3.3 INSTALLATION

#### A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Seal perimeter and other joints watertight unless otherwise indicated.

#### B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

#### C. Set continuous sill members and flashing in full sealant bed as specified in Section 079200 "Joint Sealants" to produce weathertight installation.

#### D. Install components plumb and true in alignment with established lines and grades.

#### E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

#### F. Install glazing as specified in Section 088000 "Glazing."

#### G. Install weatherseal sealant according to Section 079200 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

#### H. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. 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.

### 3.4 ERECTION TOLERANCES

#### A. Erection Tolerances: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
3. Alignment:
  - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
  - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
  - c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.6 m); 1/2 inch (12.7 mm) over total length.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed entrances and storefronts.
  1. Water Penetration Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 503 and shall not evidence water penetration, defined as any water appearing on the interior surfaces of framing or glass other than condensation.
- C. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.
- D. Should the tested units not pass the test, the Contractor is required to:
- E. 1. Correct the failed unit.
- F. 2. Re-test the failed unit at Contractor's expense until the unit passes the test.
- G. 3. Successfully test an additional unit at Contractor's expense.
- H. Prepare test and inspection reports.

END OF SECTION 084113

## SECTION 087100 - DOOR HARDWARE

### 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. Mechanical door hardware for the following:
    - a. Swinging doors.
    - b. Folding doors.
  - 2. Cylinders for door hardware specified in other Sections.
  - 3. Electrified door hardware.

- B. Related Requirements:

- 1. Section 123216 "Manufactured Plastic-Laminate-Faced Casework" for cabinet door hardware provided with cabinets.
  - 2. Section 081113 "Hollow Metal Doors and Frames".
  - 3. Section 081416 "Flush Wood Doors".
  - 4. Section 083113 "Access Doors and Frames" for access door hardware, including cylinders.
  - 5. Section 083323 "Overhead Coiling Doors" for door hardware provided as part of overhead coiling door assemblies.
  - 6. Section 084113 "Aluminum-Framed Entrances and Storefronts" for entrance door hardware, including cylinders.
  - 7. Section 102600 "Wall and Door Protection" for plastic door protection units that match wall protection units.
  - 8. Section 281300 "Access Control" for access control devices installed at door openings and provided as part of a security system.
  - 9. Section 281600 "Intrusion Detection" for detection devices installed at door openings and provided as part of an intrusion-detection system.

#### 1.3 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

- B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For electrified door hardware.
  - 1. Include diagrams for power, signal, and control wiring.
  - 2. Include details of interface of electrified door hardware and building safety and security systems.
- C. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
  - 1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
  - 2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
  - 3. Content: Include the following information:
    - a. Identification number, location, hand, fire rating, size, and material of each door and frame.
    - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
    - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
    - d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.
    - e. Fastenings and other installation information.
    - f. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
    - g. Mounting locations for door hardware.
    - h. List of related door devices specified in other Sections for each door and frame.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

- B. Sample Warranty: For special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.
- B. Schedules: Final door hardware and keying schedule.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware and keying.
  - 1. Warehousing Facilities: In Project's vicinity.
  - 2. Scheduling Responsibility: Preparation of door hardware and keying schedule.
  - 3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

#### 1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including excessive deflection, cracking, or breakage.
    - b. Faulty operation of doors and door hardware.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
  - 2. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:

- a. Electromagnetic Locks: Five years from date of Substantial Completion.
- b. Exit Devices: Two years from date of Substantial Completion.
- c. Manual Closers: 10 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of door hardware from single manufacturer.
  1. Provide electrified door hardware from same manufacturer as mechanical door hardware unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
- B. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- D. Accessibility Requirements: For door hardware on doors in an accessible route, comply with ICC A117.1.
  1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22.2 N).
  2. Comply with the following maximum opening-force requirements:
    - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
    - b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
  3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
  4. 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 position of 12 degrees from the latch.
  5. Adjust spring hinges so that, from an open position of 70 degrees, the door will take at least 1.5 seconds to move to the closed position.

## 2.3 SCHEDULED DOOR HARDWARE

- A. Provide products for each door that comply with requirements indicated in Part 2 and door hardware schedule.

1. Door hardware is scheduled on Drawings and in Section 087100.01.

## 2.4 PARTS LIST

- A. See Section 087100.01

1. Substitutions must be submitted in advance.

## 2.5 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock. Incorporate decisions made in keying conference.

1. Coordinate keying and cylinder keyway with owner's requirements.

## 2.6 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Architect.

1. Manufacturer's identification is permitted on rim of lock cylinders only.

- B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

- C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Fire-Rated Applications:

- a. Wood or Machine Screws: For the following:

- 1) Hinges mortised to doors or frames.
    - 2) Strike plates to frames.
    - 3) Closers to doors and frames.
  - b. Steel Through Bolts: For the following unless door blocking is provided:
    - 1) Surface hinges to doors.
    - 2) Closers to doors and frames.
    - 3) Surface-mounted exit devices.
3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

## 2.7 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other 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 doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.
- B. Wood Doors: Comply with door and hardware manufacturers' written instructions.

### 3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
  - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
  - 2. Custom Steel Doors and Frames: HMMA 831.
  - 3. Wood Doors: DHI's "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until blocking reinforcement and finishes have been completed on substrates involved and until 2x wood blocking is confirmed present in wall at mounting height.
  - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
  - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- D. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule, but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every 30 inches (750 mm) of door height greater than 90 inches (2286 mm).
- E. Lock Cylinders: Install construction cores to secure building and areas during construction period.
  - 1. Replace construction cores with permanent cores as directed by Owner.
  - 2. Furnish permanent cores to Owner for installation.
- F. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Architect.
  - 1. Configuration: Provide least number of power supplies required to adequately serve doors with electrified door hardware.
- G. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
  - 1. Do not notch perimeter gasketing to install other surface-applied hardware.
- H. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

- I. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

### 3.4 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
  1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

### 3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
  1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
  2. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 70 degrees and so that closing time complies with accessibility requirements of authorities having jurisdiction.
  3. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.

### 3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

### 3.7 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.8 DEMONSTRATION

- A. Engage Installer to train Owner's maintenance personnel to adjust, operate, and maintain door hardware.

3.9 DOOR HARDWARE SCHEDULE

- A. As indicated on drawings.

**Hardware Group No. 1**

For use on Door #(s):

G100

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 5 X 5 NRP	630	IVE
1	EA	POWER TRANSFER	EPT10 CON	✓ 689	VON
1	EA	REMOVABLE MULLION	KR4954 STAB	689	VON
1	EA	PANIC HARDWARE	LD-XP99-EO	626	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-XP99-NL-CON 24 VDC	✓ 626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
2	EA	MORTISE CYLINDER	20-061 ICX 36-083	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	SURFACE CLOSER	4111 EDA TBWMS	689	LCN
			PROVIDE BSD DISTRICT STD MOUNTING PLATE		
1	EA	SURF. AUTO OPERATOR	4642 WMS	✓ 689	LCN
1	EA	MOUNTING PLATE	4110-18	689	LCN
			OMIT IF TOP RAIL IS TALL ENOUGH TO MOUNT CLOSER		
1	EA	WEATHER RING	8310-801	PLA	LCN
1	EA	ACTUATOR, JAMB MOUNT	8310-818T	✓ 630	LCN
1	EA	SURFACE MOUNT BOX	8310-819S	✓ PLA	LCN
1	EA	ACTUATOR, WALL MOUNT	8310-853T	✓ 630	LCN
1	EA	FLUSH MOUNT BOX	8310-867F	✓ 689	LCN
2	EA	WALL STOP	WS406/407CVX	630	IVE
			INSTALL ON BOLLARDS		
1	EA	RAIN DRIP	346C	AL	PEM
1	EA	MULLION SEAL	5110BL	BLK	PEM
1	EA	WIRE HARNESS	CON-26P	✓	SCH
			POWER TRANSFER TO ELECTRIFIED HARDWARE		
1	EA	WIRE HARNESS	CON-6W	✓	SCH
			FROM INCOMING POWER SUPPLY		
2	EA	DOOR CONTACT	679-05HM	✓ BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 900-BBK 120/240 VAC	✓	VON
			ACCESS CONTROL - WORK OF DIVISION 28		
			BOLLARD(S) PROVIDED BY CONTRACTOR		
			PROVIDE FACTORY POINT TO POINT WIRING DIAGRAMS		
			PROVIDE RISER DIAGRAMS		
			WEATHERSTRIP, THRESHOLD, AND SWEEP(S) BY DOOR MANUFACTURER		

120VAC TO POWER SUPPLY AND ADA OPERATOR. HOME RUN FROM POWER SUPPLY TO QEL DEVICE AS FOLLOWS: 200FT/18 AWG, 320FT/16 AWG, 500FT/14 AWG, OR 800FT/12 AWG. COORDINATE CARD READER AND ACTUATOR MOUNTING LOCATIONS ON WALLS AND BOLLARDS PRIOR TO MOUNTING. DOOR CONTACT LISTED IS A PLACE HOLDER FOR PREP ONLY. DOUBLE POLE DOUBLE THROW DOOR CONTACT TO BE SUPPLIED BY DIVISION 28. WEATHER HOOD FOR CARD READER AND OR ACTUATOR TO ALSO BE SUPPLIED BY DIVISION 28.

### Hardware Group No. 2

For use on Door #(s):

G101                      G103

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	PRIVACY WITH OCCUPIED INDICATOR	L9456T 06A L583-363 L283-722	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	SURFACE CLOSER	4011 WMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS TKTX	630	IVE
1	EA	WALL STOP/HOLDER	WS40	626	IVE
			INSTALL AT TOP OF DOOR		
1	SET	SEALS	S88D	DKB	PEM

MOUNT WS40 NEAR LEADING EDGE PULL SIDE OF DOOR LIKE A MAG HOLDER ARMATURE WOULD MOUNT.

### Hardware Group No. 3

For use on Door #(s):

G102                      G104                      G106                      G108                      G114A                      G114

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	VANDL ENTRANCE LOCK	ND92TD RHO K510-066	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS TKTX	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

#### Hardware Group No. 4

For use on Door #(s):

G112

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	VANDL ENTRANCE LOCK	ND92TD RHO K510-066	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS TKTX	630	IVE
1	EA	WALL STOP	WS406/407CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

#### Hardware Group No. 5

For use on Door #(s):

G110

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	REMOVABLE MULLION	KR4954 STAB	689	VON
1	EA	PANIC HARDWARE	LD-99-EO	626	VON
1	EA	PANIC HARDWARE	LD-99-L-2SI-06	626	VON
1	EA	MULLION STORAGE KIT	MT54	689	VON
			REINFORCEMENT REQUIRED. PROVIDE BSD DISTRICT STD SPACER.		
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	MORTISE CYLINDER	20-061 ICX 36-083	626	SCH
1	EA	RIM CYL THUMBTURN	XB11-979	626	SCH
2	EA	FSIC CORE	23-030 EV29 T	626	SCH
2	EA	SURFACE CLOSER	4111 EDA TBWMS	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW B-CS TKTX	630	IVE
2	EA	WALL STOP/HOLDER	WS40	626	IVE
			INSTALL AT TOP OF DOOR		
1	EA	MULLION SEAL	5110BL	BLK	PEM
2	EA	SILENCER	SR64	GRY	IVE

**Hardware Group No. 6**

For use on Door #(s):  
G110A

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
4	EA	HINGE	5BB1HW 5 X 4.5 NRP	630	IVE
1	EA	PANIC HARDWARE	XP99-NL	626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	MORTISE CYLINDER	20-061 ICX	626	SCH
2	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	SURFACE CLOSER	4111 EDA WMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS TKTX	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
			INSTALL ON BOLLARD		
1	EA	RAIN DRIP	346C	AL	PEM
1	EA	DOOR SWEEP	315CN	AL	PEM
1	EA	THRESHOLD	172A MSES10	AL	PEM
1	EA	DOOR CONTACT	679-05HM	✓ BLK	SCE
			BOLLARD PROVIDED BY		
			CONTRACTOR		
1			WEATHERSTRIP BY		
			DOOR/FRAME MANUFACTURER		

**Hardware Group No. 7**

For use on Door #(s):  
OG1

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	2062.100	600	GGH
1	EA	PANIC HARDWARE	LD-99-NL-WH	626	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH

GATE CLOSERS BY GATE MANUFACTURER

END OF SECTION 087100

## SECTION 088000 - GLAZING

### 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. Glass for windows, doors, storefront framing, glazed curtain walls, skylights.
  - 2. Glazing sealants and accessories.

#### 1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. IBC: International Building Code.
- D. Interspace: Space between lites of an insulating-glass unit.

#### 1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

#### 1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 2. Review temporary protection requirements for glazing during and after installation.

## 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches (300 mm) square.
- C. Glazing Schedule: List glass types and thicknesses 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.

## 1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For glass.
- C. Product Test Reports: For tinted glass, insulating glass and glazing sealants, for tests performed by a qualified testing agency.
  - 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- D. Preconstruction adhesion and compatibility test report.
- E. Sample Warranties: For special warranties.

## 1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved by coated-glass manufacturer.
- B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: 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.
  - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F (4.4 deg C).

1.11 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: 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: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Insulating Glass: 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: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Products: Subject to compliance with requirements, provide Sunguard by Guardian or comparable products by, but not limited to, one of the following:

1. AGC Glass Company North America, Inc.
  2. Pilkington North America, Inc.
  3. Saint-Gobain Corporation.
  4. Oldcastle BuildingEnvelope.
- B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
1. Obtain tinted glass from single source from single manufacturer.
- C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

## 2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall 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.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.
- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
1. Design Wind Pressures: As indicated on Drawings.
  2. Design Snow Loads: As indicated on Drawings.
- D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites of thickness indicated.
  2. For laminated-glass lites, properties are based on products of construction indicated.
  3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
  4. 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).
  5. 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.
  6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

## 2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
  - 1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
  - 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
  - 1. Minimum Glass Thickness for Exterior Lites: 6 mm.
  - 2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

## 2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.
- B. Ultraclear Float Glass: ASTM C 1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent.
- C. Tinted Annealed Float Glass: ASTM C 1036, Type I, Class 2 (tinted), Quality-Q3.
- D. Fully Tempered Float Glass: 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.
  - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

- E. Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

## 2.5 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
  - 1. Sealing System: Dual seal, with primary and secondary sealants.
  - 2. Perimeter Spacer: Manufacturer's standard spacer material and construction.
  - 3. Desiccant: Molecular sieve or silica gel, or a blend of both.

## 2.6 GLAZING SEALANTS

- A. General:
  - 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
  - 2. 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.
  - 3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
- C. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
- D. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
- E. Glazing Sealant: Acid-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.

## 2.7 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
  2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
  3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
  2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

## 2.8 MISCELLANEOUS GLAZING MATERIALS

- A. General: 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 a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. 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.

## 2.9 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 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- B. 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.
- C. Grind smooth and polish exposed glass edges and corners.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
  - 1. Manufacturing and installation tolerances, including those for 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 only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

### 3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other 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 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.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

### 3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. 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.

- D. 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.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. 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.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

### 3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. 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.
- C. 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.
- D. 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 compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

### 3.6 SEALANT GLAZING (WET)

- A. 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.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

### 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, despite such protection, contaminating substances do 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.

### 3.8 MONOLITHIC GLASS SCHEDULE

- A. Glass Type CG: Ultra-clear low Iron float glass, heat strengthened.
  - 1. Minimum Thickness: 6 mm.
- B. Glass Type CTG: Uncoated Ultra-clear fully tempered float glass.
  - 1. Minimum Thickness: 6 mm.
- C. Glass Type TRTG: Translucent fully tempered float glass: Uncoated clear, acid etched on 2<sup>nd</sup> surface.
  - 1. Minimum Thickness: 6 mm.

### 3.9 INSULATING GLASS SCHEDULE

- A. Glass Type ICG: Low-E-coated, clear insulating glass.
  - 1. Overall Unit Thickness: 1 inch (25 mm).
  - 2. Minimum Thickness of Each Glass Lite: 6 mm.
  - 3. Outdoor Lite: float glass.
  - 4. Interspace Content: Air.
  - 5. Indoor Lite: float glass.
  - 6. Low-E Coating: Pyrolytic on second surface.

7. Winter Nighttime U-Factor: 0.29 maximum.
8. Summer Daytime U-Factor: 0.27 maximum.
9. Visible Light Transmittance: 60 percent minimum.
10. Solar Heat Gain Coefficient: 0.27 maximum.

B. Glass Type ICTG: Low-E-coated, clear tempered insulating glass.

1. Basis of Design: SIGMA 64-7-2
2. Overall Unit Thickness: 1 inch (25 mm).
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Fully tempered float glass.
5. Interspace Content: Air.
6. Indoor Lite: Fully tempered float glass.
7. Low-E Coating: Pyrolytic on second surface.
8. Winter Nighttime U-Factor: 0.29 maximum.
9. Summer Daytime U-Factor: 0.27 maximum.
10. Visible Light Transmittance: 60 percent minimum.
11. Solar Heat Gain Coefficient: 0.27 maximum.

C. Glass Type IG: Low-E-coated, clear insulating glass.

1. Basis of Design Product: Sunguard SN 68
2. Overall Unit Thickness: 1 inch (25 mm).
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: float glass.
5. Interspace Content: Air.
6. Indoor Lite: float glass.
7. Low-E Coating: Pyrolytic on second surface.
8. Winter Nighttime U-Factor: 0.29 maximum.
9. Summer Daytime U-Factor: 0.28 maximum.
10. Visible Light Transmittance: 68 percent minimum.
11. Solar Heat Gain Coefficient: 0.38 maximum.

D. Glass Type TIG: Low-E coated, tinted insulating glass.

1. Basis-of-Design Product: Sunguard 'CrystalGray' tinted glass with SN68 on #2.
2. Overall Unit Thickness: 1 inch (25 mm).
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Tinted heat-strengthened float glass.
5. Tint Color: Crystal Gray.
6. Interspace Content: Air.
7. Indoor Lite: Clear float glass.
8. Low-E Coating: Pyrolytic on second surface.
9. Winter Nighttime U-Factor: 0.29 maximum.
10. Summer Daytime U-Factor: 0.28 maximum.
11. Visible Light Transmittance: 34 percent minimum.
12. Solar Heat Gain Coefficient: 0.28 maximum.

- E. Decorative Glass Type SG-1/2/3: Laminated glass with decorative interlayer.
1. Basis-of-Design Product: 3Form.
  2. Construction: Two plies of clear fully tempered float glass.
  3. Thickness of Each Glass Ply: 3 mm.
  4. Construction: Laminate glass with PVB interlayer or cast-in-place and cured, transparent, resin interlayer to comply with interlayer manufacturer's written instructions.
  5. Interlayer Color and Pattern: As selected by Architect from manufacturer's full range.

END OF SECTION 088000

## SECTION 092116.23 - GYPSUM BOARD SHAFT WALL ASSEMBLIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes gypsum board shaft wall assemblies.
- B. Related Sections include the following:
  - 1. Division 5 Section "Cold-Formed Metal Framing" for other exterior and interior load-bearing and non-load-bearing wall stud and furring.
  - 2. Division 7 Section "'Joint Sealants" for acoustical sealant.
  - 3. Division 7 Section "Penetration Firestopping" for fire rated sealant.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each component of gypsum board shaft wall assembly.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and support them on risers on a flat platform to prevent sagging.

#### 1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with gypsum-shaftliner-board manufacturer's written instructions.
- B. Do not install finish panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, or mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.

2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. 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. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.

### 2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

- A. Fire-Resistance Rating: As indicated Retain "STC Rating" Paragraph below if required to reduce airborne sound transmission.
- B. STC Rating: As indicated
- C. Gypsum Shaftliner Board:
  1. Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with paper faces, 1 inch (25.4 mm) thick, with double beveled long edges.
    - a. American Gypsum; Shaft Liner.
    - b. CertainTeed Corp.; ProRoc Shaftliner.
    - c. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific; ToughRock Fireguard Shaftliner.
    - d. Lafarge North America, Inc.; Firecheck Type X Shaftliner.
    - e. National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner.
    - f. PABCO Gypsum; Pabcore Shaftliner Type X.
    - g. Temple-Inland Inc.; Fire-Rated SilentGuard Gypsum Shaftliner System.
    - h. USG Corporation; Sheetrock Brand Gypsum Liner Panel.
- D. Non-Load-Bearing Steel Framing, General: Complying with ASTM C 645 requirements for metal unless otherwise indicated and complying with requirements for fire-resistance-rated assembly indicated.
  1. Protective Coating: ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized unless otherwise indicated.
- E. Studs: Manufacturer's standard profile for repetitive, corner, and end members as follows:

## GYPSUM BOARD SHAFT WALL ASSEMBLIES

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1. Depth: As indicated Minimum Base-Metal Thickness: As indicated
- F. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches (51 mm long and matching studs in depth.
- G. Minimum Base-Metal Thickness: As indicated Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.
    - b. Metal-Lite, Inc.; The System.
- H. Elevator-Hoistway-Entrance Struts: Manufacturer's standard J-profile jamb strut with long-leg length of 3 inches (76 mm), matching studs in depth, and not less than 0.033 inch (0.84 mm thick.
- I. Finish Panels: As indicated Sound Attenuation Blankets: As specified in Section 092900 "Gypsum Board."

## 2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with shaft wall manufacturer's written instructions.
- B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in Section 092900 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written instructions for application indicated.
- C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
- D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
  1. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488/E 488M conducted by a qualified testing agency.
  2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

- E. Reinforcing: Galvanized-steel reinforcing strips with 0.033-inch (0.84-mm) minimum thickness of base metal (uncoated).
- F. Gypsum Board Cants:
  - 1. Gypsum Board Panels: As specified in Section 092900 "Gypsum Board," Type X, 1/2- or 5/8-inch (13- or 16-mm) panels.
  - 2. Adhesive: Laminating adhesive as specified in Section 092900 "Gypsum Board."
  - 3. Non-Load-Bearing Steel Framing: As specified in Section 092216 "Non-Structural Metal Framing."

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated and manufacturer's written installation instructions.
- B. Do not bridge building expansion joints with shaft wall assemblies; frame both sides of expansion joints with furring and other support.
- C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.
  - 1. Elevator Hoistway: At elevator hoistway-entrance door frames, provide jamb struts on each side of door frame.
  - 2. Reinforcing: Provide where items attach directly to shaft wall assembly as indicated on Drawings; accurately position and secure behind at least one layer of face panel.
- D. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons and floor indicators, and similar items.

- E. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels while maintaining continuity of fire-rated construction.
- F. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- G. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect while maintaining fire-resistance rating of gypsum board shaft wall assemblies.
- H. Sound-Rated Shaft Wall Assemblies: Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly.
- I. Gypsum Board Cants: At projections into shaft exceeding 4 inches (102 mm), install gypsum board cants covering tops of projections.
  - 1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches (610 mm) o.c. with screws fastened to shaft wall framing.
  - 2. Where non-load-bearing steel framing is required to support gypsum board cants, install framing at 24 inches (610 mm) o.c. and extend studs from the projection to shaft wall framing.
- J. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

### 3.3 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, or mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and 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 092116.23

## SECTION 092216 - NON-STRUCTURAL METAL 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.
- B. Related Requirements
  - 1. Division 06 Section "Miscellaneous Rough Carpentry" for general framing.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Non-load-bearing steel framing systems for interior partitions.
  - 2. Suspension systems for interior ceilings and soffits.
  - 3. Grid suspension systems for gypsum board ceilings.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.
- C. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 10 lbf/sq. ft. (480 Pa)

- D. Interior walls and partitions that exceed 6 feet in height, including their finish materials, shall have adequate strength and stiffness to resist the loads to which they are subjected but not less than a horizontal load of 5 psf per OSSC 1607.15.
- E. The design and installation of nonstructural members and connections shall be in accordance with AISI S220 per OSSC 2211.2.

## 2.2 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
  - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
  - 2. Protective Coating hot-dip galvanized unless otherwise indicated.
- B. Studs and Tracks: ASTM C 645
  - 1. Steel Studs and Tracks.
- C. Minimum Base-Metal Thickness: As required by performance requirements for horizontal deflection Slip-Type Head Joints: Where indicated, provide one of the following:
  - 1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to tracks while allowing 1-1/2-inch (38-mm) minimum vertical movement.
  - 2. Double-Track System: ASTM C 645 top outer tracks, inside track with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
  - 3. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- D. Cold-Rolled Channel Bridging: Steel, 0.0538-inch (1.367-mm) minimum base-metal thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
  - 1. Depth: 1-1/2 inches (38 mm).
  - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.
- E. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
  - 1. Minimum Base-Metal Thickness: 0.0179 inch (0.455 mm)
  - 2. Depth: 7/8 inch (22.2 mm).
- F. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.

1. Configuration: Asymmetrical or hat shaped.

## 2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- B. Hanger Attachments to Concrete:
  1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 as appropriate for the substrate.
    - a. Uses: Securing hangers to structure.
    - b. Type: Torque-controlled, expansion anchor or adhesive anchor.
    - c. 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.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.
- D. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch (1.367 mm) and minimum 1/2-inch- (13-mm-) wide flanges.
  1. Depth: 2-1/2 inches (64 mm).
- E. Furring Channels (Furring Members):
  1. Cold-Rolled Channels: 0.0538-inch (1.367-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
  2. Steel Studs and Tracks: ASTM C 645.
    - a. Minimum Base-Metal Thickness: 0.0179 inch (0.455 mm).
    - b. Depth: 1-5/8 inches (41 mm) See "Embossed Steel Studs and Tracks" Article in the Evaluations for information about embossed steel studs and tracks.
- F. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

## 2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
  1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 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.
  - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

### 3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
  - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
  - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
  - 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
  - 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

### 3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
  - 1. Single-Layer Application: As required by horizontal deflection performance requirements unless otherwise indicated.
  - 2. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- B. Install studs so flanges within framing system point in same direction.
- C. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
  - 1. Install two studs at each jamb unless otherwise indicated.
  - 2. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
  - 3. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
  - 4. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
  - 5. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
    - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
  - 6. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- D. Direct Furring:
  - 1. Screw to wood framing.
  - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
- E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

### 3.5 INSTALLING CEILING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: 48 inches (1219 mmo.c.).
  2. Carrying Channels (Main Runners): 48 inches (1219 mmo.c.).
  3. Furring Channels (Furring Members): 16 inches (406 mm).
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
    - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counter splaying, or other equally effective means.
  2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
  3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
  4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
  5. Do not attach hangers to steel roof deck.
  6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
  7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
  8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support Grid suspension systems are suitable for use with gypsum board. They might be acceptable for gypsum veneer plaster; consult gypsum veneer plaster and grid suspension system manufacturers.
- F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- G. Installation Tolerances: 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.

END OF SECTION 092216

NON-STRUCTURAL METAL FRAMING

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## SECTION 092900 - GYPSUM BOARD

### 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. Interior gypsum board.
  - 2. Tile backing panels.

- B. Related Requirements:

- 1. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
  - 2. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
  - 3. Section 093013 "Ceramic Tiling" for cementitious backer units installed as substrates for ceramic tile.

#### 1.3 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

#### 1.4 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. 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.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. 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. 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.

### 2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

### 2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Wallboard: ASTM C 1396/C 1396M.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. American Gypsum.
  2. CertainTeed Corp.
  3. Georgia-Pacific Gypsum LLC.
  4. Lafarge North America Inc.
  5. National Gypsum Company.
  6. PABCO Gypsum.
  7. Temple-Inland.
  8. USG Corporation.
- C. Gypsum Board, Type X: ASTM C 1396/C 1396M.
  1. Thickness: 5/8 inch (15.9 mm).
  2. Long Edges: Tapered.
- D. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
  1. Thickness: 1/2 inch (12.7 mm).

2. Long Edges: Tapered.
- E. Abuse-Resistant Gypsum Board: ASTM C 1396/C 1396M gypsum board, tested according to ASTM C 1629/C 1629M.
1. Core: As indicated on Drawings 5/8 inch (15.9 mm), Type X.
  2. Surface Abrasion: ASTM C 1629/C 1629M, meets or exceeds Level 2 requirements.
  3. Indentation: ASTM C 1629/C 1629M, meets or exceeds Level 2 requirements.
  4. Soft-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 2 requirements.
  5. Long Edges: Tapered.
  6. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- F. "Impact-Resistant Gypsum Board" Paragraph below describes products tested according to ASTM C 1629/C 1629M for resistance to abrasion, indentation, and soft- and hard-body impact. See "Abuse- and Impact-Resistant Gypsum Board" Article in the Evaluations for additional information. Verify availability with manufacturers.
- G. Type C gypsum board has fire-resistive capability greater than that of Type X. Design designations of independent testing agencies indicated on Drawings generally determine product requirements for Type C gypsum board. Type C gypsum board from different manufacturers cannot be intermixed because the ratings apply only to assemblies identical in materials and construction to those tested.
- H. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or ASTM C 1325, with manufacturer's standard edges.
1. Thickness: 1/2 inch (12.7 mm)
  2. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- I. Water-Resistant Gypsum Backing Board: ASTM C 1396/C 1396M, with manufacturer's standard edges.
1. Core: As indicated on Drawings
- 2.4 TRIM ACCESSORIES
- A. Interior Trim: ASTM C 1047.
1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc
  2. Shapes:
    - a. Cornerbead.
    - b. L-Bead: L-shaped; exposed long flange receives joint compound.
    - c. Expansion (control) joint.

## 2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
  - 1. Interior Gypsum Board: Paper.
  - 2. Exterior Gypsum Soffit Board: Paper.
  - 3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
  - 4. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
  - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
  - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
    - a. Use setting-type compound for installing paper-faced metal trim accessories.
  - 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
  - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
  - 5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.
- D. Joint Compound for Tile Backing Panels:
  - 1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
  - 2. Cementitious Backer Units: As recommended by backer unit manufacturer.
  - 3. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

## 2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
  - 1. 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. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

- C. Sound-Attenuation Blankets: 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.
- D. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
- E. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."
- F. Vapor Retarder: As specified in Section 072600 "Vapor Retarders."

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. 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.
- C. 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.
- D. 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.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.

### GYPSUM BOARD

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- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), 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- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) 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.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.
- J. STC-Rated Assemblies: 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's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

### 3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
  - 1. Wallboard Type: As indicated on Drawings
  - 2. Type X: As indicated on Drawings
  - 3. Ceiling Type: Ceiling surfaces
  - 4. Abuse-Resistant Type: In Gymnasium
  - 5. Impact-Resistant Type: As indicated on drawings.
  - 6. Mold-Resistant Type: As indicated on Drawings.
  - 7. Glass-Mat Interior Type: As indicated on Drawings.
- B. 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 horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
  - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
  - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. 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.
3. 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.
4. Fastening Methods: Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners

3.4 APPLYING TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.
- B. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile
- C. Water-Resistant Backing Board: Install where indicated with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.
- D. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

### 3.5 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
  - 1. Cornerbead: Use at outside corners
  - 2. L-Bead: Use where indicated or recommended by manufacturer.
  - 3. J-trim: Use at exposed edges of boards and where boards abut caulked joints with dissimilar materials.

### 3.6 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive 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
    - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
- D. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.
- E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

### 3.7 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. 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 092900

## SECTION 093013 – CERAMIC TILING

### 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. Porcelain tile.
  - 2. Glazed wall tile.
  - 3. Crack isolation membrane.
  - 4. Metal edge strips.

- B. Related Requirements:

- 1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
  - 2. Section 092900 "Gypsum Board" for cementitious backer units.

#### 1.3 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."
- C. Module Size: Actual tile size plus joint width indicated.
- D. Face Size: Actual tile size, excluding spacer lugs.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Verification:
  1. Full-size units of each type and composition of tile and for each color and finish required.
  2. Full-size units of each type of trim and accessory.
  3. Stone thresholds in 6-inch (150-mm) lengths.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Certificates: For each type of product.
- D. Product Test Reports: For tile-setting and -grouting products.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- 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 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.

#### 1.8 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.

- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

## 1.9 FIELD 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.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
  - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
  - 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
  - 2. Obtain crack isolation membrane, except for sheet products, from manufacturer of setting and grouting materials.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
  - 1. Crack isolation membrane.

### 2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
  - 1. Provide tile complying with Standard grade requirements.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced

by TCNA installation methods specified in tile installation schedules, and other requirements specified.

- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

## 2.3 TILE PRODUCTS

### A. Tile Type CT-1: Colorbody porcelain tile.

1. Products: Basis-of-Design products from Daltile, Kestones.
2. Certification: Tile certified by the Porcelain Tile Certification Agency.
3. Face Size: 2 by 2 inches.
4. Face Size Variation: Rectified.
5. Thickness: 1/4 inch.
6. Face: Speckle.
7. Finish: Matte
8. Dynamic Coefficient of Friction: Not less than 0.42.
9. Tile Color, Glaze, and Pattern: As indicated in Color and Materials Schedule in drawings or if not indicated, as selected by Architect from full range of industry colors.
10. Grout Color: As indicated in Color and Materials Schedule in drawings or

### B. Tile Type CT-2, CT-2A, CT-2B, CT-3: Glazed wall tile.

1. Products: Basis-of-Design products from Daltile, Semi-Gloss.
2. Certification: Tile certified by the Porcelain Tile Certification Agency.
3. Face Size: 4.25 x 4.25 inches.
4. Face Size Variation: Rectified.
5. Thickness: 5/16 inch
6. Face: Solid with square edges.
7. Dynamic Coefficient of Friction: N/A.
8. Tile Color, Glaze, and Pattern: As indicated in Color and Materials Schedule in drawings or if not indicated, as selected by Architect from full range of industry colors.
9. Grout Color: As selected by Architect from manufacturer's full range.
10. Grout Color: As selected by Architect from manufacturer's full range.

### C. Tile Base CT-2C: Glazed wall tile.

1. Products: Basis-of-Design products from Daltile, Semi-Gloss.
2. Module Size: 4.25" x 6" cove.
3. Thickness: 5/16 inch.
4. Face: Solid color, with manufacturer's standard edges.
5. Finish: Gloss.
6. Tile Color and Pattern: As indicated in Color and Materials Schedule in drawings or if not indicated, as selected by Architect from full range of industry colors.
7. Grout Color: As selected by Architect from manufacturer's full range.

## 2.4 CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.12 for standard performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and fabric reinforcement.
- C. Crack Isolation Membrane and Tile-Setting Adhesive: One-part, fluid-applied product intended for use as both a crack isolation membrane and tile-setting adhesive in a two-step process.

## 2.5 SETTING MATERIALS

- A. Portland Cement Mortar Installation Materials: Provide materials complying with ANSI A108.1 and as specified below.
  - 1. Latex additive (water emulsion) described below, of type specifically recommended by latex additive manufacturer for use with job-mixed portland cement and aggregate mortar bed.
    - a. Latex Additive: Manufacturer's standard.
- B. Latex-Portland Cement Mortar: ANSI A118.4, composition as follows:
  - 1. Latex additive (water emulsion) of type described below, combined at job site with prepackaged dry mortar mix supplied or specified by latex additive manufacturer.
    - a. Latex Type: Manufacturer's standard.
    - b. Latex-Portland Cement Mortar shall be quality similar to Custom Building Products ProLite Tile and Stone Mortar.

## 2.6 GROUT MATERIALS

- A. Chemical-Resistant Epoxy Grout: ANSI A118.3. Manufacturer standard colors:
- B. Quality of epoxy grout used on this Project shall be similar to Custom Building Products CEG-Lite.

## 2.7 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

- B. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, designed specifically for flooring applications; exposed-edge material.
  - 1. Outside Corners (SCHL-1): Schluter Systems anodized aluminum Schiene.
    - a. Schiene to be used at wall tile at flash coved base areas only.
  - 2. Outside Corners (SCHL-2): Schluter Systems anodized aluminum Rondec.
    - a. Rondec to be used at outside corners of wall tile.
- C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

## 2.8 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

## 2.9 ELASTOMERIC SEALANTS

- A. General: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer indicated that comply with requirements of Division 07 Section "Joint Sealants," including ASTM C 920 as referenced by Type, Grade, Class, and Uses.
- B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.
- C. One-Part Mildew-Resistant Silicone Sealant: Type S; Grade NS; Class 25; Uses NT, G, A, and as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and temperature extremes.
- D. Products: Subject to compliance with requirements, provide one of the following:
  - 1. One-Part Mildew-Resistant Silicone Sealant:
    - a. "Dow Corning 786"; Dow Corning Corp.
    - b. "Sanitary 1700"; GE Silicones.

- c. "898 Sanitary Silicone Sealant"; Pecora Corp.
- d. "Rhodorsil 6B White"; Rhone-Poulenc Inc.
- e. "Tremsil 600 White"; Tremco Corp.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
  - 2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
    - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
    - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
  - 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
  - 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

### 3.3 CERAMIC TILE INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
  - 1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
    - a. Tile floors in wet areas.
    - b. Tile floors consisting of tiles 8 by 8 inches (200 by 200 mm) or larger.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- E. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
  - 1. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
  - 2. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
  - 1. Glazed Wall Tile: 1/8 inch (3.2 mm).
  - 2. Porcelain Floor Tile: 1/8 inch (3.2 mm).
- G. Lay out tile wainscots to dimensions indicated.
- H. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

- I. Metal Edge Strips: Install at locations indicated.

### 3.4 CRACK ISOLATION MEMBRANE INSTALLATION

- A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
- B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

### 3.5 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
  1. Remove grout residue from tile as soon as possible.
  2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

### 3.6 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

### 3.7 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete Subfloor:

1. Floor Tile, Typical: Install tile to comply with requirements indicated below for setting bed methods, TCNA installation methods related to types of subfloor construction, and grout types:
  - a. Crack Isolation Mat: TCNA F125-Partial Coverage.
  - b. Latex Modified Portland Cement Mortar: ANSI A108.4
  - c. Bond Coat: Latex-portland cement mortar, ANSI A108.4 or ANSI A108.5.
    - 1) Concrete Subfloors, Typical: TCNA F115-13 on medium bed.
    - 2) Grout: Water-cleanable epoxy grout.
- B. Interior Wall Installations, Wood or Metal Studs or Furring:
  1. Tile Installation TCNA W244C - 13; thinset mortar on cementitious backer units.
    - a. Thinset Mortar: Latex Portland Cement Mortar: ANSI A108.4.
    - b. Grout: Water-cleanable epoxy grout.

END OF SECTION 093013

## SECTION 095113 - ACOUSTICAL PANEL CEILINGS

### 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 acoustical panels and exposed suspension systems for interior ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, provide 6 inch (150 mm) sample size.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Product Test Reports: For each acoustical panel ceiling, for tests performed by a qualified testing agency.
- C. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- 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.

## ACOUSTICAL PANEL CEILINGS

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1. Acoustical Ceiling Units: 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.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

#### 1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, 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.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc.

#### 2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. 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: Class A according to ASTM E 1264.
  2. Smoke-Developed Index: 50 or less.

## 2.3 ACOUSTICAL PANELS (APC-1)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Fine Fissured, 895 as manufactured by Armstrong World Industries, Inc.
- B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- C. Classification: Provide panels as follows:
  - 1. Type and Form: Type XII, mineral-fiber base with membrane-faced overlay; Form 2, cloth. Binder shall not contain urea formaldehyde.
  - 2. Pattern: E (lightly textured)] Fine
- D. Color: As indicated in Color and Materials Schedule in drawings or if not indicated, as selected by Architect from full range of industry colors.
- E. Light Reflectance (LR): 0.81
- F. Noise Reduction Coefficient (NRC): 0.55
- G. Ceiling Attenuation Class (CAC): Not less than 35.
- H. Edge/Joint Detail: Square Lay-in
- I. Thickness: 5/8 inch
- J. Modular Size: 24 by 48 inches
- K. Antimicrobial Treatment: Manufacturer's standard broad spectrum, 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, ASTM D 3274, or ASTM G 21 and evaluated according to ASTM D 3274 or ASTM G 21.

## 2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
  - 1. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for "Coating Classification for 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.

- C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
  2. 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 0.135-inch- (3.5-mm-) diameter wire.
- D. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
- E. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
- F. Seismic Clips: seismic clips designed and spaced to secure acoustical panels in place.
1. Hemmed aluminum-capped angle molding with prefinished exposed flanges, 7/8" width. Basis of Design Seismic clip: BERC2 retaining clip.

## 2.5 METAL SUSPENSION SYSTEM

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Prelude XL as manufactured by Armstrong World Industries, Inc:
- B. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C 635/C 635M and designated by type, structural classification, and finish indicated.
1. High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" according to ASTM C 635/C 635M.
- C. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 (Z90) coating designation; with prefinished 15/16 inch wide metal caps on flanges.
1. Structural Classification: Intermediate-duty system.
  2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
  3. Face Design: Flat, flush.
  4. Cap Material: Cold-rolled steel.
  5. Cap Finish: As indicated in Color and Materials Schedule in drawings or if not indicated, as selected by Architect from full range of industry colors.

## 2.6 ACCESSORIES

- A. 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.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
  - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
  - 2. Size: Wire diameter sufficient for 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 not less than 0.106-inch- (2.69-mm-) diameter wire.
- C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- E. 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.
- F. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
- G. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
- H. Three way clips: GC3W Grip clip 3-Way for APC-1

## 2.7 METAL EDGE MOLDINGS AND TRIM

- A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
  - 1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
    - a. Moldings for seismic constraint; Basis of Design Product: BERC2 retaining clip, part of the Seismic RX system by Armstrong World Industries, Inc.
  - 2. Where indicated on drawings 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.
    - a. Armstrong Shadow Molding

3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
  - B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's 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.
    1. 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.
  - C. Seismic Restraint Wall Moldings: Hemmed aluminum-capped angle molding with prefinished exposed flanges, 7/8" width. Basis of Design Seismic clip: BERC2 retaining clip.
- 2.8 METAL EDGE MOLDINGS AND TRIM (Perimeter Termination not adjacent to walls)
- A. Basis-of-Design Product: Subject to compliance with requirements, provide Axiom Classic as manufactured by Armstrong World Industries, Inc., or a comparable product by one of the following:
  - B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's 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.
    1. 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.
- 2.9 ACOUSTICAL SEALANT
- A. Acoustical Sealant: As recommended by manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections 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 only after unsatisfactory conditions have been corrected.

### 3.2 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 unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

### 3.3 INSTALLATION

- A. Install acoustical panel ceilings according to ASTM C 636/C 636M and manufacturer's written instructions and Cisca's "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 only 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 to structure 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 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.
- 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. 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. Miter corners accurately and connect securely.
  3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. 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 precise fit.
1. Arrange directionally patterned acoustical panels as follows:
    - a. As indicated on reflected ceiling plans.
  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. 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.

### 3.4 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m), non-cumulative.

- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m), non-cumulative.

### 3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
  - 1. Compliance of seismic design.

### 3.6 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.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

## SECTION 095423 - LINEAR METAL CEILINGS

### 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 linear metal suspension systems for both interior and exterior ceilings.
- B. Related Requirements:
  - 1. Section 095113 "Acoustical Panel Ceilings" for clip-in, lay-in, snap-in, and torsion-spring-hinged metal pan ceilings with exposed suspension systems.
  - 2. Section 054000 "Cold-Formed Metal Framing" for framing members.

#### 1.3 DEFINITIONS

- A. LR: Light Reflectance coefficient.
- B. NRC: Noise Reduction Coefficient.

#### 1.4 COORDINATION

- A. Coordinate layout and installation of linear metal pans and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

#### 1.5 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

#### 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: For components with factory-applied color and other decorative finishes.

## LINEAR METAL CEILINGS

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- C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below:
1. Linear Metal Pan: Set of 12-inch- (300-mm-) long Samples of each type and color and a 12-inch- (300-mm-) long spliced section.
  2. Suspension System Members: 12-inch- (300-mm-) long Sample of each type.
  3. Exposed Molding and Trim: Set of 12-inch- (300-mm-) long Samples of each type, finish, and color.
  4. Filler Strips: Set of 12-inch- (300-mm-) long Samples of each type, finish, and color.
  5. Sound Absorber: 12 inches (300 mm) long.
  6. End Cap: Full size.
- D. Delegated-Design Submittal: For design of seismic restraints and attachment devices.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Linear pattern.
  2. Joint pattern.
  3. Ceiling suspension members.
  4. Method of attaching hangers to building structure.
    - a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
  5. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
  6. Ceiling perimeter and penetrations through ceiling; trim and moldings.
  7. Minimum Drawing Scale: 1/8 inch.
- B. Qualification Data: For testing agency.
- C. Product Test Reports: For each linear metal ceiling, for tests performed by a qualified testing agency.
- D. Evaluation Reports: For linear metal ceiling and components.
- E. Field quality-control reports.

#### 1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.9 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. Linear Metal Ceiling Components: Quantity of each pan, carrier, accessory, and exposed molding and trim equal to 2 percent of quantity installed.

1.10 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by National Voluntary Laboratory Accreditation Program for testing indicated.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for materials and execution.
  - 1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Deliver linear metal pans, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Handle linear metal pans, suspension system components, and accessories carefully to avoid damaging units and finishes in any way.

1.12 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install linear metal ceilings until spaces are enclosed and weather-tight, 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements" to design seismic restraints and attachment devices.

- B. Structural Performance: Exterior linear metal ceilings shall withstand exterior exposure and the effects of gravity loads and the following loads and stresses without showing permanent deformation of ceiling system components including pans and suspension system; noise or metal fatigue caused by vibration, deflection, and displacement of ceiling pans; or permanent damage to fasteners and anchors:
1. Wind Load: Uniform pressure as indicated on Drawings, acting inward or outward.
  2. Seismic Criteria: Provide linear metal ceilings designed and installed to withstand the effects of earthquake motions according to the following:
    - a. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580/E 580M.
    - b. CISCAs Recommendations for Acoustical Ceilings: Comply with CISCAs "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings - Seismic Zones 0-2."
    - c. CISCAs Guidelines for Systems Requiring Seismic Restraint: Comply with CISCAs "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies - Seismic Zones 3 & 4."
    - d. ASCE/SEI 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C) material surfaces.
- D. 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: Comply with ASTM E 1264 for Class A materials.
  2. Smoke-Developed Index: 50 or less.

## 2.2 LINEAR METAL CEILING PANS

- A. Acoustical Metal Pan Standard: Provide manufacturer's standard linear metal pans of configuration indicated that comply with ASTM E 1264 classifications as designated by types, acoustical ratings, and light reflectances unless otherwise indicated.
1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface per ASTM E 795.
- B. Sheet Metal Characteristics: For metal components exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, roughness, stains, or discolorations.

1. Aluminum Sheet: Roll-formed aluminum sheet, complying with ASTM B 209 (ASTM B 209M); alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
  2. Steel Sheet: Commercial-quality, cold-rolled, carbon-steel sheet; stretcher leveled; with protective coating complying with ASTM C 635/C 635M.
    - a. Painted Finishes: Electrolytic zinc-coated steel complying with ASTM A 879/A 879M, 04Z (12G) coating; surface treatment as recommended by finish manufacturer for type of use and finish indicated.
    - b. Chemical/Mechanical Finishes: Uncoated steel sheet complying with ASTM A 1008/A 1008M with luster or bright finish as required by finisher for applying electroplating or other metallic-finishing processes.
  3. Stainless-Steel Sheet: Complying with ASTM A 240/A 240M.
  4. Extruded Aluminum complying with ASTM D 958 – Practice for Determining Temperatures of Standard ASTM Molds for Test Specimens of Plastics and ASTM B221.
- C. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated to snap on and be securely retained on carriers without separate fasteners, and finished to comply with requirements indicated.
- D. Pan Splices: Construction same as pans, in lengths 8 to 12 inches (200 to 300 mm); with manufacturer's standard finish.
- E. End Caps: Manufacturer's standard material; fabricated to fit and conceal exposed ends of pans.
- F. Filler Strips: Manufacturer's standard material; fabricated to uninterruptedly close voids between pans.
- G. Moldings and Trim: Provide manufacturer's standard moldings and trim for exposed members, and as indicated or required, for edges and penetrations of ceiling, around fixtures, at changes in ceiling height, and for other conditions; of same metal and finish as linear metal ceiling pans.
- H. Sound-Absorbent Fabric Layer: Provide fabric layer, sized to fit concealed surface of pan, and consisting of black, nonwoven, nonflammable, sound-absorbent material with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing per ASTM E 84.
1. Bond fabric layer to pan in the factory with manufacturer's standard nonflammable adhesive.
- I. Sound-Absorbent Pads: Provide width and length to completely fill between carriers, joined at center of panel, with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing per ASTM E 84, and to comply with the following requirements:

1. Plastic Sheet-Wrapped Mineral-Fiber Insulation: Pads consisting of non-rigid, PVC plastic sheet encapsulating un-faced mineral-fiber insulation complying with ASTM C 553, Type I, II, or III, and as follows:
  - a. Mineral-Fiber Type and Thickness: Glass fiber; 1 inch (25 mm).
  - b. Mineral-Fiber Density: 3/4 lb/cu. ft. (12 kg/cu. m).
  - c. Plastic Sheet Thickness and Color: Not less than 0.003 inch (0.076 mm); flat black.
2. Unwrapped, Glass-Fiber Insulation: Black-coated, un-faced, glass-fiber insulation complying with ASTM C 553, Type I, II, or III, not less than 1-lb/cu. ft. (16-kg/cu. m) density, treated to be non-dusting, and as follows:
  - a. Thickness: 1 inch (25 mm).

## 2.3 METAL SUSPENSION SYSTEMS

- A. Metal Suspension Systems Standard: Provide ceiling manufacturer's standard metal suspension systems of types and finishes indicated that comply with applicable ASTM C 635/C 635M requirements.
- B. Suspension Systems: Provide systems complete with carriers, splice sections, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, fixture adapters, and other suspension components required to support ceiling units and other ceiling-supported construction.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, Direct Hung, unless otherwise indicated.
  1. Cast-in-Place and Post-Installed Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per ASTM E 488/E 488M or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
    - a. Type: Postinstalled expansion anchors.
    - b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC service condition (mild).
    - c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchors.
    - d. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.
  2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without

failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

- D. Wire Hangers, Braces, and Ties: Provide wire complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
  2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
  3. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
  4. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C 635/C 635M, Table 1, Direct Hung is less than yield stress of wire, but provide not less than 0.135-inch- (3.5-mm-) diameter wire.
- E. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- F. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed from 0.04-inch- (1.0-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.
- G. Carriers: Factory finished with matte-black baked finish.
1. Main Carriers: Aluminum, not less than 0.240-inch (6.0-mm) rolled sheet, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, complying with ASTM B 209 (ASTM B 209M).
  2. Main Carriers: Steel, not less than 0.0209-inch (0.53-mm) nominal thickness, cold-rolled sheet, with factory-applied protective coating, complying with ASTM C 635/C 635M.
    - a. Electrolytic Zinc-Coated Steel: ASTM A 879/A 879M, not less than 08Z (24G) zinc coating.
    - b. Hot-Dip Galvanized Steel: ASTM A 653/A 653M, not less than G60 (Z180) zinc coating.
  3. Adaptable Carriers: Manufacturer's standard carriers for direct attachment to existing suspended tees.
  4. Flexible Radial Carriers: Manufacturer's standard radial carriers.
  5. Expansion Carriers: Manufacturer's standard carriers allowing for irregularities or other unusual space conditions.
- H. Carrier Splices: Same metal, profile, and finish as for carriers.
- I. Stabilizer Channels, Tees, and Bars: Manufacturer's standard components for stabilizing main carriers at regular intervals and at light fixtures, air-distribution equipment, access doors, and other equipment; spaced as standard with manufacturer for use indicated; and factory finished with matte-black baked finish.
- J. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

- K. Exterior Bracing: Cold-rolled steel channels and angles, hot-dip galvanized to comply with ASTM A 653/A 653M, G60 (Z180) coating designation; size and profile as required to withstand wind load.
- L. Hold-Down Clips: Manufacturer's standard hold-down clips spaced as standard with manufacturer.
- M. Attachment Clips: Manufacturer's standard attachment clip spaced as required by the manufacturer's installation requirements.
- N. Edge Moldings and Trim: Provide exposed members as indicated or required to comply with seismic requirements of authorities having jurisdiction, to conceal edges of penetrations through ceiling, to conceal ends of pans and carriers, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching linear metal pans or extruded plastic unless otherwise indicated.
  - 1. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.

2.4 LINEAR METAL CEILING (Existing)

- A. Products: Provide Armstrong, Inc. Metalworks Linear or comparable products from
  - 1. United States Gypsum Company.
  - 2. CertainTeed Corporation.
- B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- C. Classification: Provide panels as follows:
  - 1. Type and Form ASTM E1264 Classification, Class A
  - 2. Pattern: C micro-perforated
- D. Color: As indicated in Color and Materials Schedule in drawings or if not indicated, as selected by Architect from full range of industry colors.
- E. Light Reflectance (LR): 0.61.
- F. Noise Reduction Coefficient (NRC): 0.85.
- G. Ceiling Attenuation Class (CAC): N/A.
- H. Edge/Joint Detail: Square Lay-in.
- I. Thickness: 5/8 inch.

LINEAR METAL CEILINGS

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- J. Modular Size: 6 by 96 inches.
- K. Antimicrobial Treatment: Manufacturer's standard broad spectrum, 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, ASTM D 3274, or ASTM G 21 and evaluated according to ASTM D 3274 or ASTM G 21.

## 2.5 LINEAR METAL CEILING (Existing)

- A. Products: Provide Longboard Premium Soffit & Siding or comparable products from:
  - 1. United States Gypsum Company.
  - 2. CertainTeed Corporation.
  - 3. Armstrong, Inc.
- B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- C. Classification: Provide panels as follows:
  - 1. V-Groove type, 6 inches wide.
  - 2. Pattern: Unperforated with vent soffit panels.
- D. Color: As indicated in Color and Materials Schedule in drawings or if not indicated, as selected by Architect from full range of industry colors.

## 2.6 GENERAL 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. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

## 2.7 ALUMINUM FINISHES

- A. Mill Finish: AA-M10C10.
- B. Lacquered Mill Finish: AA-M10C10R1x with manufacturer's standard clear, organic coating.

## LINEAR METAL CEILINGS

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- C. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
- D. Clear Mirror Anodic Finish: AA-M21C12A212, 0.005 mm or thicker.
- E. Color-Coated Finish: Manufacturer's standard powder-coat baked paint finish complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.
- F. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
- G. Finish for LMC-2 shall be manufacturer's standard Alluminate certified AAMA 2606/2605 compliant, and be VOC, Chrome & Phosphate Free and TGIC Free.

## 2.8 GALVANIZED-STEEL SHEET FINISHES

- A. Color-Coated Finish: Manufacturer's standard powder-coat baked paint finish complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

## 2.9 STEEL SHEET FINISHES

- A. Electroplated Finish: Electroplating process complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, and minimum thickness to produce a coating uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unplated areas, and other visible defects.
- B. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical, bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

## 2.10 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
  - 1. Run grain of directional finishes with long dimension of each piece.
  - 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which linear metal ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of linear metal ceilings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Measure each ceiling area and establish layout of linear metal pans to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width pans at borders, and comply with layout shown on reflected ceiling plans and on Coordination Drawings.

### 3.3 INSTALLATION

- A. Comply with ASTM C 636/C 636M and seismic requirement indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- 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 only where required to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, 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 to which hangers are attached and for type of hanger involved.
  - 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 and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that does 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, post-installed 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 but without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.
- D. Install edge moldings and trim of type indicated at perimeter of linear metal ceiling area and where necessary to conceal edges and ends of linear metal pans.
1. 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.
  2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension system carriers so they are aligned and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Cut linear metal pans for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness exceeding referenced standards for stretcher-leveled metal sheet.
- G. Install linear metal pans in coordination with suspension system and exposed moldings and trim.
1. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated.
  2. Fit adjoining units to form flush, tight joints. Scribe and cut units for accurate fit at borders and around construction penetrating ceiling.
  3. Install pans with butt joints using internal pan splices and in the following joint configuration:
    - a. Aligned.
    - b. Aligned, every other pan length.
    - c. Staggered a minimum of 12 inches (300 mm).
    - d. Random.
    - e. As indicated.
  4. Install directionally textured metal pans in directions indicated.

5. Where metal pan ends are visible, install end caps unless trim is indicated.
6. Install filler strips where indicated.
7. Install sound-absorbent pads at right angle to perforated metal pans so pads do not hang unsupported.

H. Install hold-down clips where indicated.

I. For LMC-2 panels, install with manufacturer's mounting clip, using starter strips and finishing caps. Aluminum components shall be adequately isolated from galvanized steel framing members.

### 3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Suspended ceiling system.
2. Hangers, anchors, and fasteners.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Tests and Inspections: Testing and inspecting of completed installations of linear metal ceiling hangers and anchors and fasteners shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with installations of linear metal ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.

1. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.

- a. Within each test area, testing agency will select 1 of every 10 power-actuated fasteners and post-installed anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select 1 of every 2 post-installed anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
- b. 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. Linear metal ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 CLEANING

- A. Clean exposed surfaces of linear metal ceilings, including trim and edge moldings after removing strippable, temporary protective covering if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, 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, including dented and bent units.

END OF SECTION 095423

## SECTION 096513 - RESILIENT BASE AND ACCESSORIES

### 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. Resilient base.
  - 2. Resilient molding accessories.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 4 inches (300 mm) long.
- C. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

#### 1.4 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. Furnish not less than 10 linear feet (3 linear m) for every 500 linear feet (150 linear m) or fraction thereof, of each type, color, pattern, and size of resilient product installed.

#### 1.5 QUALITY ASSURANCE

- A. Fire Performance Characteristics: Provide products with the following fire performance characteristics as determined by testing products per ASTM test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
  - 1. Critical Radiant Flux: 0.45 watts per sq. cm or more per ASTM E 648.
  - 2. Smoke Density: Less than 450 per ASTM E 662.

- B. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for resilient base.
- C. Provide 5-year unconditional warranty for installation.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

#### 1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive resilient products 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 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Install resilient products after other finishing operations, including painting, have been completed.

### PART 2 - PRODUCTS

#### 2.1 RESILIENT WALL BASE (RB-1)

- A. Products: Basis-of-Design products from Johnsonite, Inc. Traditional Rubber Base or comparable product by one of the following:
  - 1. Roppe Corporation, USA.
  - 2. VPI Corporation.
- B. Product Standard: ASTM F 1861
  - 1. Group: I (solid, homogeneous).
  - 2. Meet or exceed ASTM E 84/NFPA 225 – Class A flame spread index, less than 450 smoke density.
  - 3. Style:

- a. Toeless on carpeted floors
  - b. Cove on resilient, concrete floors
- C. Thickness: 1/8"
- D. Height: 4 inches (102 mm).
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Preformed.
- G. Inside Corners: Job formed.
- H. Colors: As indicated in Color and Materials Schedule in drawings or if not indicated, as selected by Architect from full range of industry colors.

## 2.2 RUBBER MOLDING ACCESSORY

- A. Products: Refer to profile type for Basis-of-Design or select comparable product by one of the following:
  - 1. Roppe Corporation, USA.
  - 2. VPI Corporation
  - 3. Johnsonite
- B. Description: Rubber carpet edge for glue-down applications reducer strip for resilient flooring.
- C. Profile and Dimensions: As indicated or as scheduled below.
  - 1. Carpet edge for glue down applications (carpet to concrete, carpet to rubber): Roppe profile #38
  - 2. Carpet to Carpet application: Johnsonite T-Moulding CD-XX-C
- D. Locations: All areas where two dissimilar materials come together.
- E. Colors and Patterns: As indicated in Color and Materials Schedule in drawings or if not indicated, as selected by Architect from full range of industry colors.

## 2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, with Installer present, 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 in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

#### 3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products 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 products and installation materials into spaces where they will be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

#### 3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.

### RESILIENT BASE AND ACCESSORIES

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- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.
- H. Job-Formed Corners:
  - 1. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.
    - a. Cope corners to minimize open joints.

### 3.4 PREFABRICATED FLASH COVE BASE INSTALLATION

- A. Prefabricated Flash Cove Base Application:
  - 1. Provide prefabricated flash cove base for integral base indicated in Finish Schedule.
  - 2. Dry-fit prefabricated flash cove base; cut and fit material to required lengths. Miter-cut inside and outside corners.
  - 3. Dry-fit and cut metal cove cap prior to prefabricated flash cove base installation.
  - 4. Scribe glue line on walls and floor at edge of prefabricated flash cove base material.
  - 5. Apply adhesive in full spread (100% coverage on 2 surfaces) for full length of prefabricated flash cove base material. Apply prefabricated flash cove base to wall surface straight and level.
  - 6. Slide metal base cap behind prefabricated flash cove base material.
  - 7. Hand roll prefabricated flash cove base material onto wall and floor surface removing bumps, ripples and fishmouths. Remove excess adhesive.
  - 8. weld seams as recommended by manufacturer in prefabricated flash cove base material.

### 3.5 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. 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.

### 3.6 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
  - 1. Remove adhesive and other blemishes from exposed surfaces.
  - 2. Sweep and vacuum horizontal surfaces thoroughly.

- 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from marks, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

## SECTION 096516 - RESILIENT SHEET FLOORING

### 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. Resilient sheet flooring (RES-#).
- B. Related Requirements:
  - 1. Section 096513 "Resilient Base and Accessories" for resilient base and transition strips.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: For each type of product indicated.
- C. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.
- D. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.
- E. Qualification Data: For Installer.
- F. Maintenance Data: For each type of floor tile to include in maintenance manuals.

#### 1.4 MAINTENANCE MATERIAL SUBMITTALS

- 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. Resilient Sheet Flooring: Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for resilient product installation and seaming method indicated.
  - 1. Engage an installer who employs workers for this Project who are trained or certified by resilient product manufacturer for installation techniques required.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  - 1. Coordinate mockups in this Section with mockups specified in other Sections.
    - a. Size: Minimum 100 sq. ft. for each type, color, and pattern in locations indicated.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

## 1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following 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 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient products, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
  - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

### 2.2 RESILIENT FLOORING, RES-1

- A. Basis-of-Design Product: Altro Symphonia Commercial Safety Sheet Vinyl Flooring by Altro USA, Inc.; [www.altrofloors.com](http://www.altrofloors.com), or approved substitution.
- B. Material Standard: ASTM F1303, Type I, Grade 1, Class A moisture resistant backing.
- C. Slip Resistance: ASTM D2047; 0.9 dry, 0.8 wet.
- D. Size: Refer to Color and Finish Schedule on Drawings.
- E. Thickness: Overall, 0.08 inch (2.0 mm); Wear layer, 0.8mm wear layer, heterogeneous construction
- F. Color and Pattern: As specified in Color and Finish Schedule on Drawings.
- G. Application: As indicated Room Finish Schedule on Drawings.

### 2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient flooring manufacturer for resilient products and substrate conditions indicated.
- C. Threshold: Provide stainless steel threshold at Refrigerator and Freezer doors for transition from RES-1.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, with Installer present, 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 in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F710.
  - 1. Verify that 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 manufacturer. Do not use solvents.
  - 3. Alkalinity and Adhesion Testing: Perform tests recommended by 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: Perform tests so that each test area does not exceed 200 sq. ft. Perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    - b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
- 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. Do not install resilient products until materials are the same temperature as space where they are to be installed.
  - 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

### 3.3 RESILIENT BASE AND ACCESSORY INSTALLATION

- A. As specified in Section 096513 "Resilient Base and Accessories."

### 3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
  - 1. Remove adhesive and other blemishes from surfaces.
  - 2. Sweep and vacuum horizontal surfaces thoroughly.
  - 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096516

## SECTION 096813 - TILE CARPETING

### 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 modular carpet tile.
- B. Related Requirements:
  - 1. Section 096513 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
  - 2. Include manufacturer's written installation recommendations for each type of substrate.
- B. Shop Drawings: For carpet tile installation, plans showing the following:
  - 1. Carpet tile type, color, and dye lot.
  - 2. Type of subfloor.
  - 3. Type of installation.
  - 4. Pattern of installation.
  - 5. Pattern type, location, and direction.
  - 6. Pile direction.
  - 7. Type, color, and location of edge, transition, and other accessory strips.
  - 8. Transition details to other flooring materials.
- C. Samples: For each of the following 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.
  - 1. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- (300-mm-) long Samples.

- D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
- E. Sustainable Product Certification: Provide ANSI/NSF 140 certification for carpet products.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.
- C. Sample Warranty: For special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
  - 1. Methods for maintaining carpet tile, 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 tile.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- 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. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd. (8.3 sq. m).

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
  - 1. Build mockups at locations and in sizes shown on Drawings.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- C. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI's "CRI Carpet Installation Standard."

1.9 FIELD CONDITIONS

- A. Comply with CRI's "CRI Carpet Installation Standard" for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weather-tight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.10 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
  - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
  - 2. Failures include, but are not limited to, the following:
    - a. More than 10 percent edge raveling, snags, and runs.
    - b. Dimensional instability.
    - c. Excess static discharge.
    - d. Loss of tuft-bind strength.
    - e. Loss of face fiber.
    - f. Delamination.
  - 3. Warranty Period: 10 years.

## PART 2 - PRODUCTS

### 2.1 CARPET TILE (CPT-1 & CPT-2)

- A. Products: Basis-of-Design products from Interface, Harmonize/Groundwaves or comparable by one of the following
  - 1. Patcraft.
  - 2. Mannington Mills, inc.
- B. Generally retain "Color" and "Pattern" paragraphs below unless they are described by product designation inserted above.
- C. Color: As indicated in Color and Materials Schedule in drawings or if not indicated, as selected by Architect from full range of industry colors.
- D. Pattern: As indicated in Color and Materials Schedule in drawings or if not indicated, as selected by Architect from full range of industry colors.
- E. Fiber Content: 100% Recycled content Type 6 Nylon
- F. Product Construction: Tufted texture loop.
- G. Pile Characteristic: loop.
- H. Pile Thickness: 0.106 inches for finished carpet tile according to ASTM D 6859.
- I. Total Thickness: 0.26 inches.
- J. Surface Pile Weight: 16 oz./sq. yd.
- K. Pile Density: 5,434 oz/sq. yd.
- L. Primary Backing/Back-Coating: Manufacturer's standard composite materials.
- M. Backing System: GlasBacRE®.
- N. Size: 25cm x 1m.
- O. Performance Characteristics:
  - 1. Flooring Radiant Panel: Passes according to ASTM E-648.
  - 2. Traffic Classification: Heavy
  - 3. Flammability: Passes Methenamine Pill Test (DOC-FF1-70).

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine carpet tile for type, color, pattern, and potential defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: None (will be used as loose carpet squares/area rugs in classrooms).
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns recommended in writing by carpet tile manufacturer.
- E. Install pattern parallel to walls and borders.

#### 3.3 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
  - 1. Remove yarns that protrude from carpet tile surface.
  - 2. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI's "Carpet Installation Standard," Section 20, "Protecting Indoor Installations."
- C. Protect carpet tile 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 tile manufacturer.

END OF SECTION 096813

## SECTION 099113 - EXTERIOR PAINTING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on exterior substrates. All labor, materials, tools and other equipment, services and supervision required to complete all exterior painting and decorating work as indicated on Finish Schedules and to the full extent of the Drawings and Specifications. Exterior paint systems will be utilized for exterior substrates.
- B. Related Requirements:
  - 1. Division 5 Section "Structural Steel Framing".
  - 2. Division 5 Section "Metal Fabrications".
  - 3. Division 8 Section "Hollow Metal Doors and Frames".
  - 4. Division 8 Section "Door Hardware" for preparation prior to finishing of existing doors and frames to remain.
  - 5. Division 9 Section "Interior Painting" for surface preparation and the application of paint systems on interior substrates.
  - 6. Division 9 Section "Staining and Transparent Finishing" for surface preparation and the application of wood stains and transparent finishes on exterior wood substrates.

#### 1.2 DEFINITIONS

- A. Gloss Level 1: Matte or Flat Finish: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 3: Eggshell Finish: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 4: Satin Finish: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- D. Gloss Level 5: Semi-Gloss Finish: 35 to 70 units at 60 degrees, according to ASTM D 523.
- E. Gloss Level 6: Gloss Finish: 70 to 85 units at 60 degrees, according to ASTM D 523.
- F. Gloss Level 7: High Gloss Finish: More than 85 units at 60 degrees, according to ASTM D 523.

### 1.3 REFERENCES

A. ASTM International:

1. ASTM C834 – Latex Sealing Compounds.
2. ASTM D16 – Standard Terminology Relating to Paint, Varnish, Lacquer, and Related Products.
3. ASTM D4442 – Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.

B. Architectural Painting Specification Manual by the Master Painters Institute (MPI), including Evaluation, Systems, Preparation and Approved Product List (MPI Manual).

C. Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 (for Surface Coatings) of the Environmental Protection Agency (EPA).

### 1.4 SYSTEM DESCRIPTION

A. Painting and finishing shall include all coating systems materials, including primers, emulsions (except asphalt based), enamels, stains, sealers and fillers and other applied materials, whether used as prime, intermediate or finish coats.

B. Materials to Be Finished:

1. Unless otherwise indicated in documents, all Work receives painting and finishing. Consult Drawings, Schedules, and other Specification Sections for complete requirements. Where materials required to be finished are not indicated in the Finish Schedule or Drawings, refer to the MPI Manual for the appropriate finish; provide premium grade finish.
2. Existing construction receives painting and finishing as indicated. Consult Drawings, Schedules, and other Specification Sections for complete requirements. Where materials required to be finished are not indicated in the Finish Schedule or Drawings, refer to the MPI Manual for the appropriate finish; provide premium grade finish.

C. Materials Not to Be Finished:

1. Finished metal surfaces of anodized aluminum, polyvinylidene fluoride (PVDF), stainless steel, chromium plate, copper, bronze and similar finished metals will not require finish painting, except as indicated otherwise.
2. Glass and plastic, except as noted otherwise.
3. Materials having complete factory finish or that require installer finishing, except as indicated otherwise. Shop priming of ferrous metal items and shop-fabricated components is included under various Sections.
4. Walls and ceilings in concealed and generally inaccessible areas, above suspended ceilings, furred areas, pipe spaces, duct shafts, and the like.
5. Acoustical ceiling tile and their suspension systems, unless indicated otherwise.
6. Concrete floors, except as indicated to be painted.

7. CMU walls, except as indicated on Drawings to be painted.
8. Moving parts of operating units, moving parts of mechanical and electrical units, linkages, sensing devices, motor and fan shafts, and the like.
9. Code-required labels such as Underwriter's Laboratories, Factory Mutual, and Warnock-Hershey or any equipment identification, performance rating, name or nomenclature plates, and the like.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
  1. Submit Samples on rigid backing, 8 inches square.
  2. Step coats on Samples to show each coat required for system.
  3. Label each coat of each Sample.
  4. Label each Sample for location and application area.
- C. Product List: For each product indicated, include the following:
  1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
  2. VOC content.

## 1.6 MAINTENANCE MATERIAL SUBMITTALS

- 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: 5 percent, but not less than 1 gal. of each material and color applied.

## 1.7 QUALITY ASSURANCE

- A. Quality Standard:
  1. Work of this Section shall conform to not less than the minimum standards for material and Work including inspection and warranty requirements set forth in the MPI Manual.
  2. Work of this Section shall be of the grade and finish system in Accordance with the MPI as indicated in Painting and Finishing Schedule in Part 3 of this Section.
- B. Qualifications:
  1. Product Manufacturers: As listed in PART 2 of this Section. No substitutions.

C. Regulatory Requirements:

1. Comply with applicable federal, state, and local requirements and publications pertaining to environmental protection and the protection of the health and safety of workers, visitors to the site, and persons occupying the Project Site.
2. Where conflict among requirements or with this specification exists, the most stringent shall govern.

1.8 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 deg F.
1. Maintain containers in clean condition, free of foreign materials and residue.
  2. Remove rags and waste from storage areas daily.

1.9 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Perform no exterior painting work unless environmental conditions are within MPI and paint manufacturer's requirements or until adequate weather protection is provided. Where required, suitable weatherproof covering and sufficient heating facilities shall be in place to maintain minimum ambient air and substrate temperatures for 24 hours before, during and after paint application.
- C. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3° C) above the dew point; or to damp or wet surfaces.
- D. Perform no painting or decorating work when the maximum moisture content of the substrate exceeds:
- a. 15% for wood.
  - b. 12% for plaster and gypsum board.
- E. Conduct all moisture tests using a properly calibrated electronic Moisture Meter.

1.10 SPECIAL PROJECT WARRANTY

- A. Warranty: Furnish a 100% two (2) year Maintenance Bond. The Maintenance Bond shall warrant that all painting work has been performed in accordance with accepted industry quality standards.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. The Sherwin Williams Company (Basis of Design).
- B. The following manufacturers will be considered for substitution subject to compliance with procedures specified in Section 012500 Product Requirements, and the properties specified for each product in the PART 3 EXTERIOR PAINTING SCHEDULE.
  - 1. Benjamin Moore.
  - 2. PPG.
  - 3. Rodda Paint Company.

### 2.2 PAINT, GENERAL

- A. Materials:
  - 1. All materials used on this job (primers, paints, coatings, varnishes, stains, lacquers, fillers, etc.) shall be from a single source manufacturer for each system used.
  - 2. Other materials such as linseed oil, shellac, thinners, solvents, etc., shall be the highest quality product, compatible with paint materials being used as required.
  - 3. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.

### 2.3 EQUIPMENT

- A. Painting and Decorating Equipment: To best trade standards for type of product and application.
- B. Spray Painting Equipment: Of ample capacity, suited to the type and consistency of paint or coating being applied and kept clean and in good working order at all times.

### 2.4 MIXING AND TINTING

- A. Unless otherwise specified herein or pre-approved, all paint shall be ready-mixed and pre-tinted. Re-mix all paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and color and gloss uniformity.
- B. Paste, powder or catalyzed paint mixes shall be mixed in strict accordance with manufacturer's written instructions.
- C. Where thinner is used, addition shall not exceed paint manufacturer's recommendations. Do not use kerosene or any such organic solvents to thin water-based paints.

- D. If required, thin paint for spraying according in strict accordance with paint manufacturer's instructions. If directions are not on container, obtain instructions in writing from manufacturer and provide copy of instructions to Consultant.

## 2.5 FINISH AND COLORS

- A. Refer to Color and Material Schedule and Drawings for identification and location of colors.

## 2.6 GLOSS AND SHEEN RATINGS:

- A. As indicated in Part 3 of these Specifications.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
  - 1. Concrete: 12 percent.
  - 2. Masonry (Clay and CMU): 12 percent.
  - 3. Wood: 15 percent.
  - 4. Portland Cement Plaster: 12 percent.
  - 5. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
  - 1. Application of coating indicates acceptance of surfaces and conditions.

## 3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.

- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
  - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
  - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer.
- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- G. Wood Substrates:
  - 1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.
  - 2. Sand surfaces that will be exposed to view, and dust off.
  - 3. Prime edges, ends, faces, undersides, and backsides of wood.
  - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

### 3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations.
  - 1. Use applicators and techniques suited for paint and substrate indicated.
  - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
  - 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
  - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

- B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. 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.
- E. Exterior Mechanical and Electrical Equipment:
  - 1. General: Exterior painting and finishing of mechanical and electrical items includes all exposed items whether factory-finished or not.
  - 2. Additional painting and finishing of mechanical and electrical items is indicated in Divisions 23 and 26.

### 3.4 FIELD QUALITY CONTROL

- A. Tolerances: Final application shall match color and texture of approved samples and shall be smooth, uniform in appearance, color, texture, sheen, and shall be free of runs, sags, holidays, lap marks, air bubbles, pin holes, and other detrimental effects in accordance with requirements of the MPI and this Specification.
- B. Inspection and Testing:
  - 1. Provide and pay for inspection and testing of the Work of this Section in accordance with the warranty provisions of the MPI.
  - 2. Inspection Agency's Duties:
    - a. Provide qualified personnel at Project Site. Cooperate with Architect and Contractor in performance of services.
    - b. Perform required inspection, sampling, and testing of Products and applications and ascertain compliance with requirements of MPI.
    - c. After each inspection and test, submit 1 copy of written report within 5 calendar days to Architect and Contractor. Include in each report the Project title, date of report, date and time of inspection, weather conditions during visit, name of inspector, identification of Product and substrate, location in Project, type of inspection or test, results of tests, and whether results indicate conformity with Contract Documents.
    - d. Promptly notify Architect and Contractor in writing of observed irregularities or non-conformity of workmanship or Projects. When requested by Architect, provide interpretation of test results, evaluation of analysis of cause (in event of test failure), and recommendations for remedial action.

3. Inspection Agency's Limitations:

- a. Inspection Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
- b. Inspection Agency may not approve or accept any portion of the Work for Owner or Architect.
- c. Inspection Agency may not assume duties of Contractor or Applicator.
- d. Inspection Agency has no authority to stop the Work.

4. Applicator's Duties:

- a. Pay inspection fees associated with inspection and warranty requirements set forth in MPI.
- b. Notify inspection agency not less than 10 full working days prior to beginning Work of this Section.
- c. Notify inspection agency not less than 2 full working days prior to expected time for operations requiring inspection or testing services.
- d. Allow full access to the Work. Cooperate with inspection and testing personnel in performance of their duties of inspecting and testing of Work.
- e. Provide incidental labor and facilities to provide access to Work to be inspected or tested. Repair destructive testing sites.
- f. Correct deficiencies noted by Inspection Agency.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage 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. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

- A. Structural Steel and Metal Fabrications (including steel doors and frames):
  - 1. Two Alkyd Coats (over alkyd primer).
  - 2. Finish Sheen: Gloss Level 5.
    - a. Primer: S-W Kem Kromik Universal Metal Primer B50WZ1.

- b. Finish: S-W Direct-to-Metal Enamel Alkyd Semi-Gloss B55 Series.
- B. Galvanized-Metal Substrates (including metal deck and hollow metal frames):
  - 1. Two Alkyd Coats (over acrylic primer).
  - 2. Finish Sheen: Gloss Level 5.
    - a. Primer: S-W Kem Kromik Univeral Metal Primer B50WZ1.
    - b. Finish: S-W Direct-to-Metal Enamel Alkyd Semi-Gloss B55 Series.
- C. Aluminum:
  - 1. Two Alkyd Coats (over wash primer).
  - 2. Finish Sheen: Gloss Level 5.
    - a. Primer: S-W DTM Wash Primer, B71Y1.
    - b. Finish: S-W Direct-to-Metal Enamel Alkyd Semi-Gloss B55 Series.
- D. Dressed Lumber: to be Painted (including fascia boards, wood doors, frames and window trim).
  - 1. Two, 100% Acrylic Coats (over alkyd primer).
  - 2. Finish Sheen: Gloss Level 5.
    - a. Primer: S-W Exterior Oil-Based Wood Primer, Y24 Series.
    - b. Finish: S-W Solo 100% Acrylic Int/Ext Semi-Gloss, A76 Series.
- E. Wood Paneling: to be Stained, (siding and soffits).
  - 1. Two Coats: Stain, exterior, solvent based, semi-transparent.
  - 2. Finish Sheen: Gloss Level 1.
    - a. Finish: S-W SuperDeck Oil-Base Semi-Transparent Stain.
- F. Plastic (ABS, PVA, PVC materials, fabrications, etc.):
  - 1. Two, 100% Acrylic Coats (over acrylic adhesion promoting primer).
  - 2. Finish Sheen: Gloss Level 5.
    - a. Primer: S-W Multi-Purpose Latex Primer B51-450 Series.
    - b. Finish: S-W Solo 100% Acrylic Int/Ext Semi-Gloss, A76 Series.
  - 3. Finish Sheen: Gloss Level 5.
- G. Lumber siding: to be Stained, (cedar).
  - 1. Two Coats: Stain, exterior, solvent based, semi-transparent.
  - 2. Finish Sheen: Gloss Level 1.
    - a. Finish: S-W SuperDeck Oil-Base Semi-Transparent Stain.

H. Cement Board Substrates:

1. Two, 100% Acrylic Coats (over acrylic primer).
2. Finish Sheen: Gloss Level 5.
  - a. Primer: S-W Loxon Concrete & Masonry Primer A24W8300, (unless factory primed)
  - b. Finish: S-W Solo 100% Acrylic Int/Ext Semi-Gloss, A76 Series

END OF SECTION 099113

## SECTION 099123 - INTERIOR PAINTING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on interior substrates. All labor, materials, tools and other equipment, services and supervision required to complete all interior painting and decorating work as indicated on Finish Schedules and to the full extent of the Drawings and Specifications. Interior paint systems will be utilized for interior substrates.
- B. Related Requirements:
  - 1. Section 087100 "Door Hardware" for preparation prior to finishing of existing doors and frames to remain
  - 2. Section 099113 "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.

#### 1.2 DEFINITIONS

- A. Gloss Level 1: Matte or Flat Finish: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 3: Eggshell Finish: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 4: Satin Finish: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- D. Gloss Level 5: Semi-Gloss Finish: 35 to 70 units at 60 degrees, according to ASTM D 523.
- E. Gloss Level 6: Gloss Finish: 70 to 85 units at 60 degrees, according to ASTM D 523.
- F. Gloss Level 7: High Gloss Finish: More than 85 units at 60 degrees, according to ASTM D 523.

#### 1.3 REFERENCES

- A. ASTM International:
  - 1. ASTM C834 – Latex Sealing Compounds.
  - 2. ASTM D16 – Standard Terminology Relating to Paint, Varnish, Lacquer, and Related Products.

3. ASTM D4442 – Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-base Materials.
- B. Architectural Painting Specification Manual by the Master Painters Institute (MPI), including Evaluation, Systems, Preparation and Approved Product List (MPI Manual).
- C. Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 (for Surface Coatings) of the Environmental Protection Agency (EPA).

#### 1.4 SYSTEM DESCRIPTION

- A. Painting and finishing shall include all coating systems materials, including primers, emulsions (except asphalt based), enamels, stains, sealers and fillers and other applied materials, whether used as prime, intermediate or finish coats.
  1. Materials to Be Finished:
    - a. Unless otherwise indicated in documents, all Work receives painting and finishing. Consult Drawings, Schedules, and other Specification Sections for complete requirements. Where materials required to be finished are not indicated in the Finish Schedule or Drawings, refer to the MPI Manual for the appropriate finish; provide premium grade finish.
  2. Materials Not to Be Finished:
    - a. Finished metal surfaces of anodized aluminum, polyvinylidene fluoride (PVDF), stainless steel, chromium plate, copper, bronze, and similar finished metals will not require finish painting, except as indicated otherwise.
    - b. Glass and plastic, except as noted otherwise.
    - c. Materials having complete factory finish or that require installer finishing, except as indicated otherwise. Shop priming of ferrous metal items and shop-fabricated components is included under various Sections.
    - d. Walls and ceilings in concealed and generally inaccessible areas, above suspended ceilings, furred areas, pipe spaces, duct shafts, and the like.
    - e. Acoustical ceiling tile and their suspension systems, unless indicated otherwise.
    - f. Concrete floors, except as indicated to be painted.
    - g. CMU except where indicated to be painted.
    - h. Moving parts of operating units, moving parts of mechanical and electrical units, linkages, sensing devices, motor and fan shafts, and the like.
    - i. Code-required labels such as Underwriter's Laboratories, Factory Mutual, and Warnock-Hershey or any equipment identification, performance rating, name or nomenclature plates, and the like.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
  - 1. Submit Samples on rigid backing, 8 inches square.
  - 2. Step coats on Samples to show each coat required for system.
  - 3. Label each coat of each Sample.
  - 4. Label each Sample for location and application area.
- C. Product List: For each product indicated, include the following:
  - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
  - 2. VOC content.

## 1.6 MAINTENANCE MATERIAL SUBMITTALS

- 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: 5 percent, but not less than 1 gal. of each material and color applied.

## 1.7 QUALITY ASSURANCE

- A. Quality Standard:
  - 1. Work of this Section shall conform to not less than the minimum standards for material and Work including inspection and warranty requirements set forth in the MPI Manual.
  - 2. Work of this Section shall be of the grade and finish system in accordance with the MPI as indicated in Painting and Finishing Schedule in Part 3 of this Section.
- B. Qualifications:
  - 1. Product Manufacturers: As listed in MPI and Color and Material Schedule in Drawings. No substitutions.
  - 2. Applicator: Company specializing in and regularly engaged in performing Work of this Section with not less than three (3) years experience. Maintain regular work force of qualified journey-level personnel, trained, skilled, and experienced in performing required Work and constant competent supervision. Apprentices may be employed working under qualified journeymen's directions in accordance with trade regulations.

C. Regulatory Requirements:

1. Comply with applicable federal, state, and local requirements and publications pertaining to environmental protection and the protection of the health and safety of workers, visitors to the site, and persons occupying the Project Site.
2. Where conflict among requirements or with this specification exists, the most stringent shall govern.

1.8 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 deg F.
1. Maintain containers in clean condition, free of foreign materials and residue.
  2. Remove rags and waste from storage areas daily.

1.9 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Perform no interior painting or decorating work unless adequate continuous ventilation and sufficient heating facilities are in place to maintain ambient air and substrate temperatures above minimum requirements for 24 hours before, during and after paint application. Provide supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.
- C. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- D. Apply paint only to dry, clean, properly cured and adequately prepared surfaces in areas where dust is no longer generated by construction activities such that airborne particles will not affect the quality of finished surfaces.
- E. Perform no painting or decorating work unless a minimum lighting level of 323 Lux (30 foot candles) is provided on surfaces to be painted or decorated. Adequate lighting facilities shall be provided by the General Contractor.
- F. Perform no painting or decorating work when the maximum moisture content of the substrate exceeds:
1. 15% for wood.
  2. 12% for plaster and gypsum board.
- G. Conduct all moisture tests using a properly calibrated electronic moisture meter.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. As listed in the INTERIOR PAINTING SCHEDULE.
  - 1. Sherwin Williams (Basis-of-Design).
  - 2. Benjamin Moore (Basis-of-Design).
  - 3. Rodda Paint Company.
  - 4. Miller Paint.
- B. The following manufacturers will be considered for substitution subject to compliance with procedures specified in Section 016000 PRODUCT REQUIREMENTS and the properties specified for each product in the PART 3 INTERIOR PAINTING SCHEDULE.
  - 1. PPG.

### 2.2 PAINT, GENERAL

- A. Materials:
  - 1. Only materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, etc) listed in the latest edition of the MPI Approved Product List (APL) are acceptable for use on this project. All such material shall be from a single source manufacturer for each system used.
  - 2. Other materials such as linseed oil, shellac, thinners, solvents, etc shall be the highest quality product of an MPI listed manufacturer and shall be compatible with paint materials being used as required.
- B. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 1. Flat Paints and Coatings: 50 g/L.
  - 2. Nonflat Paints and Coatings: 150 g/L.
  - 3. Dry-Fog Coatings: 400 g/L.
  - 4. Primers, Sealers, and Undercoaters: 200 g/L.
  - 5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
  - 6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
  - 7. Pretreatment Wash Primers: 420 g/L.
  - 8. Floor Coatings: 100 g/L.
  - 9. Shellacs, Clear: 730 g/L.
  - 10. Shellacs, Pigmented: 550 g/L.

## 2.3 EQUIPMENT

- A. Painting and Decorating Equipment: To best trade standards for type of product and application.
- B. Spray Painting Equipment: Of ample capacity, suited to the type and consistency of paint or coating being applied and kept clean and in good working order at all times.

## 2.4 MIXING AND TINTING

- A. Unless otherwise specified herein or pre-approved, all paint shall be ready-mixed and pre-tinted. Re-mix all paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and color and gloss uniformity.
- B. Paste, powder or catalyzed paint mixes shall be mixed in strict accordance with manufacturer's written instructions.
- C. Where thinner is used, addition shall not exceed paint manufacturer's recommendations. Do not use kerosene or any such organic solvents to thin water-based paints.
- D. If required, thin paint for spraying according in strict accordance with paint manufacturer's instructions. If directions are not on container, obtain instructions in writing from manufacturer and provide copy of instructions to Consultant.

## 2.5 FINISH AND COLORS

- A. Unless otherwise specified herein, all painting work shall be in accordance with MPI Premium Grade finish requirements.
- B. Refer to Color and Material Schedule and Drawings for identification and location of colors.
- C. Except as noted herein or indicated in the Color and Material Schedule, interior walls and ceiling surfaces shall be painted in accordance with the following criteria over appropriate prime / sealer coat:
  - 1. All areas (except as noted): washable latex with GL3 (eggshell) finish.
  - 2. Laundry facilities / rooms, public wash / shower / bathrooms: washable latex with G5 (semi-gloss) finish.
  - 3. Public change / wash / shower rooms with institutional facility bathing and shower rooms: G5 (semi-gloss) finish for wet surfaces.
  - 4. Public and institutional facility "clean" or "sanitary" areas such as food preparation and laboratory areas: G5 (semi-gloss) finish for dry surfaces.
- D. Access doors, prime coated butts, and other prime coated hardware, registers, radiators and covers, exposed piping and electrical panels shall be painted to match adjacent surfaces (i.e. same color, texture and sheen), unless otherwise noted or where pre-finished.

- E. Plywood service panels (e.g. electrical, telephone, and cable vision panels) including edges shall be back-primed and painted to match painted wall mounted on.
- F. The inside of light valances shall be painted gloss white.
- G. The inside of all duct work behind louvers, grills and diffusers for a minimum of 18" (460 mm) or beyond sight-line, whichever is greater, shall be painted using flat black (non-reflecting) paint.

## 2.6 GLOSS AND SHEEN RATINGS

- A. As indicated in Part 3 of these Specifications.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
  - 1. Concrete: 12 percent.
  - 2. Masonry (Clay and CMU): 12 percent.
  - 3. Wood: 15 percent.
  - 4. Portland Cement Plaster: 12 percent.
  - 5. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
  - 1. Application of coating indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

## INTERIOR PAINTING

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1. Carefully clean and replace all such items upon completion of painting work in each area. Do not use solvent or reactive cleaning agents on items that will mar or remove finishes (e.g. lacquer finishes).
  2. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Protect all adjacent interior surfaces and areas, including rating and instruction labels on doors, frames, equipment, piping, etc., from painting operations and damage with drop cloths, shields, masking, templates, or other suitable protective means and make good any damage caused by failure to provide such protection.
- E. Substrate defects shall be made good and sanded by others ready for painting particularly after the first coat of paint. Start of finish painting of defective surfaces (e.g. gypsum board) shall indicate acceptance of substrate and any costs of making good defects shall be borne by the painter including re-painting of entire defective surface (no touch-up painting).
- F. Wood Substrates:
1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
  2. Sand surfaces that will be exposed to view, and dust off.
  3. Prime edges, ends, faces, undersides, and backsides of wood.
  4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

### 3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations.
1. Use applicators and techniques suited for paint and substrate indicated.
  2. 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.
  3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
  4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. 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.

### 3.4 FIELD QUALITY CONTROL

- A. Tolerances: Final application shall match color and texture of approved samples and shall be smooth, uniform in appearance, color, texture, sheen, and shall be free of runs, sags, holidays, lap marks, air bubbles, pin holes, and other detrimental effects in accordance with requirements of the MPI and this Specification.
- B. Inspection and Testing:
  - 1. Provide and pay for inspection and testing of the Work of this Section in accordance with the warranty provisions of the MPI.
  - 2. Inspection Agency's Duties:
    - a. Provide qualified personnel at Project Site. Cooperate with Architect and Contractor in performance of services.
    - b. Perform required inspection, sampling, and testing of Products and applications and ascertain compliance with requirements of MPI.
    - c. After each inspection and test, submit 1 copy of written report within 5 calendar days to Architect and Contractor. Include in each report the Project title, date of report, date and time of inspection, weather conditions during visit, name of inspector, identification of Product and substrate, location in Project, type of inspection or test, results of tests, and whether results indicate conformity with Contract Documents.
    - d. Promptly notify Architect and Contractor in writing of observed irregularities or non-conformity of workmanship of Projects. When requested by Architect, provide interpretation of test results, evaluation of analysis of cause (in event of test failure), and recommendations for remedial action.
  - 3. Inspection Agency's Limitations:
    - a. Inspection Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
    - b. Inspection Agency may not approve or accept any portion of the Work for Owner or Architect.
    - c. Inspection Agency may not assume duties of Contractor or Applicator.
    - d. Inspection Agency has no authority to stop the Work.

4. Applicator's Duties:

- a. Pay inspection fees associated with inspection and warranty requirements set forth in MPI.
- b. Notify inspection agency not less than 10 full working days prior to beginning Work of this Section.
- c. Notify inspection agency not less than 2 full working days prior to expected time for operations requiring inspection or testing services.
- d. Allow full access to the Work. Cooperate with inspection and testing personnel in performance of their duties of inspecting and testing of Work.
- e. Provide incidental labor and facilities to provide access to Work to be inspected or tested. Repair destructive testing sites.
- f. Correct deficiencies noted by Inspection Agency.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage 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. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

- A. Concrete Horizontal Surfaces (floors and stairs):
  1. Two water-based urethane/epoxy coats (over TBD primer).
  2. Finish Sheen: Gloss Level 5.
    - a. Primer: Same as Finish.
    - b. Finish: S-W ArmorSeal 8100, Water Based Epoxy Floor Coating, B70-8100 Series (<50 g/L VOC).
- B. Structural Steel and Metal Fabrications (columns, beams, joists, etc.):
  1. Two water-based light industrial Coats (over alkyd primer).
  2. Finish Sheen: Gloss Level 5.
    - a. Primer: S-W Kem Kromik Universal Metal Primer.

- b. Finish: S-W Pro Industrial Acrylic Semi-Gloss, B66 Series, (<50 g/L VOC).
- C. Galvanized Metal (doors, frames, misc. steel, pipes, overhead decking, ducts, etc.):
  - 1. Two water-based light industrial Coats (over alkyd primer).
  - 2. Finish Sheen: Gloss Level 5.
    - a. Primer: S-W Kem Kromik Universal Metal Primer.
    - b. Finish: S-W Pro Industrial Acrylic Semi-Gloss, B66 Series, (<50 g/L VOC).
- D. Galvanized Metal (hand railings, guard rails):
  - 1. Two water-based urethane coats (over alkyd primer).
  - 2. Finish Sheen: Gloss Level 5.
    - a. Primer: S-W Kem Kromik Universal Metal Primer.
    - b. Finish: S-W HydroGloss Single Component W/B Urethane B65W181 Series, (<250 g/L VOC).
- E. Glue Laminated Beams and Columns:
  - 1. Three water-based coats water-based urethane varnish.
  - 2. Lightly sand between coats.
  - 3. Finish Sheen: Gloss Level 2.
    - a. Prime Coat: Same as Finish Coat
    - b. Finish: S-W Minwax Polycrylic Protective Finish 3333 (<275 g/L VOC)
- F. Dimensional Lumber (columns, beams, exposed joists, underside of decking, etc.):
  - 1. Three water-based coats water-based urethane varnish.
  - 2. Lightly sand between coats.
  - 3. Finish Sheen: Gloss Level 2.
    - a. Prime Coat: Same as Finish Coat.
    - b. Finish: S-W Minwax Polycrylic Protective Finish 3333 (<275 g/L VOC).
- G. Dressed Lumber (including doors, door and window frames, casings, molding, etc.):
  - 1. Three water-based coats water-based urethane varnish.
  - 2. Lightly sand between coats.
  - 3. Finish Sheen: Gloss Level 2.
    - a. Prime Coat: Same as Finish Coat.
    - b. Finish: S-W Minwax Polycrylic Protective Finish 3333 (<275 g/L VOC).
- H. Wood Paneling and Casework (partitions, panels, shelving, millwork, benches etc.):

1. Three water-based coats water-based urethane varnish.
  2. Lightly sand between coats.
  3. Finish Sheen: Gloss Level 2.
    - a. Prime Coat: Same as Finish Coat.
    - b. Finish: S-W Minwax Polycrylic Protective Finish 3333 (<275 g/L VOC).
- I. Wood Floors and Stairs (including hardwood flooring, etc.):
1. Three water-based coats water-based urethane varnish.
  2. Lightly sand between coats.
  3. Finish Sheen: Gloss Level 2.
    - a. Prime Coat: S-W Minwax Water Based Polyurethane for Floors (<250 g/L VOC) thinned 10 %.
    - b. Finish: S-W Minwax Water Based Polyurethane for Floors (<250 g/L VOC).
- J. Plaster and Gypsum (Standard Living Spaces, Class Rooms Offices, Hallways, etc.):
1. Two vinyl acrylic coats (over vinyl acrylic primer).
  2. Finish Sheen: Gloss Level 3 or 4.
    - a. Primer: S-W ProMar 200 Zero VOC Interior Latex Primer B28W02600 (Volume Solids: 26% ± 2%).
    - b. Finish: S-W ProMar 200 Zero VOC Int Latex Egg Shell, B20-2600 Series (Volume Solids: 42 ± 2%).
- K. Plaster and Gypsum (Damp areas with higher maintenance requirements including Kitchens, Toilets, and Maintenance Spaces):
1. Two water-based high performance acrylic coats (over vinyl acrylic primer).
  2. Finish Sheen: Gloss Level 5.
    - a. Primer: S-W ProMar 200 Zero VOC Interior Latex Primer B28W02600 (Volume Solids: 26% ± 2%).
    - b. Finish: S-W Pro Industrial Acrylic Semi-Gloss, B66 Series, (<50 g/L VOC), (Volume Solids: 35 ± 2%).
- L. Plaster and Gypsum (Wet areas such as Shower Rooms):
1. Two solvent-based epoxy coats (over appropriate primer).
  2. Finish Sheen: Gloss Level 5.
    - a. Primer: S-W ProMar 200 Zero VOC Interior Latex Primer B28W02600 (Volume Solids: 26% ± 2%).
    - b. Finish: S-W Macropoxy 646-100 Fast Cure Epoxy B58-620 (<100 g/L VOC).

M. Exposed Ceilings:

1. S-W Pro Industrial Waterborne Acrylic Dryfall Eggshell B42W00082 (<50 g/L VOC).

END OF SECTION 099123

## SECTION 099300 - STAINING AND TRANSPARENT FINISHING

### 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 surface preparation and application of wood finishes on the following substrates:
  - 1. Interior Substrates:
    - a. Dressed lumber (finish carpentry).
    - b. Exposed wood panel products.

#### 1.3 DEFINITIONS

- A. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include preparation requirements and application instructions.
- B. Samples for Verification: For each type of finish system and in each color and gloss of finish indicated.
  - 1. Submit Samples on representative samples of actual wood substrates, 8 inches (200 mm) square or 8 inches (200 mm) long.
- C. Product List: For each product indicated, include the following:
  - 1. Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules.
  - 2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the product proposed for use highlighted.
  - 3. VOC content.

## 1.5 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 deg F (7 deg C).
  - 1. Maintain containers in clean condition, free of foreign materials and residue.
  - 2. Remove rags and waste from storage areas daily.

## 1.6 FIELD CONDITIONS

- A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply finishes when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.
- C. Do not apply exterior finishes in snow, rain, fog, or mist.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Benjamin Moore & Co.
  - 2. Cabot Incorporated, Samuel.
  - 3. Diamond Vogel Paints.
  - 4. Duron, Inc.
  - 5. ICI Paints.
  - 6. PPG Architectural Finishes, Inc.
  - 7. Sherwin-Williams Company (The)

### 2.2 MATERIALS, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:
  - 1. Provide materials for use within each finish system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

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2. For each coat in a finish system, provide products recommended in writing by manufacturers of topcoat for use in finish system and on substrate indicated.

C. Stain Colors: As selected by Architect from manufacturer's full range

## 2.3 WOOD FILLERS

A. Wood Filler Paste: MPI #91.

## 2.4 PRIMERS AND SEALERS

A. Alkyd Sanding Sealer: MPI #102.

1. Basis-of-Design Product: PPG Architectural Finishes, Inc.; Speedhide Quick Dry Alkyd Sanding Sealer, Series 6-10.

B. Waterbourne acrylic sealer:

1. Basis-of-Design Product: Lenmar DuraLaq-WB® 1WB.10x.

## 2.5 STAINS

A. Stain, Semi-Transparent, for Interior Wood: MPI #90.

1. Basis-of-Design Product: PPG Architectural Finishes, Inc.; REZ Interior Wood Stain Semi-Transparent, Series 77-560.

B. Stain, Semi-Transparent for Exterior Wood: MPI #13 (check back on PPG's website, it is currently down).

## 2.6 POLYURETHANE VARNISHES

A. Varnish, Interior, Polyurethane, Oil-Modified, Satin (Gloss Level 4): MPI #57.

## 2.7 WATERBOURNE ACRYLIC CLEAR FINISH

A. Waterbourne acrylic clear finish for interior applications. Satin (Gloss Level 4).

1. Basis-of-Design Product: Lenmar DuraLaq-WB® 1WB.10x.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Exterior Wood Substrates: 15 percent, when measured with an electronic moisture meter.
- C. Maximum Moisture Content of Interior Wood Substrates: 10 percent, when measured with an electronic moisture meter.
- D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- E. Proceed with finish application only after unsatisfactory conditions have been corrected.
  - 1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

#### 3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.
  - 1. After completing finishing operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each particular substrate condition and as specified.
  - 1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
  - 2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.
  - 3. Countersink nails and fill with putty or plastic wood filler tinted to final color. Sand smooth when dried.
- D. Exterior Wood Substrates:

### STAINING AND TRANSPARENT FINISHING

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1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Prime edges, ends, faces, undersides, and backsides of wood.
  - a. For varnish coated stained wood, stain edges and ends and prime with varnish. Prime undersides and backsides with varnish.

E. Interior Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Apply wood filler paste to open-grain woods, as defined in "MPI Architectural Painting Specification Manual," to produce smooth, glasslike finish.
3. Sand surfaces that will be exposed to view and dust off.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

- A. Apply finishes according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
1. Use applicators and techniques suited for finish and substrate indicated.
  2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
  3. Do not apply finishes over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

### 3.5 EXTERIOR WOOD FINISH SYSTEM SCHEDULE

#### A. Cedar Soffits

1. Water Based Varnish.
  - a. Stain Coat: Stain, semi-transparent for exterior wood, MPI #13.
  - b. First Intermediate Coat: Water-based varnish matching topcoat.
  - c. Second Intermediate Coat: Water-based varnish matching topcoat.
  - d. Topcoat: Varnish, water based, clear, stain (Gloss Level 4), MPI #128.

### 3.6 INTERIOR WOOD-FINISH-SYSTEM SCHEDULE

#### A. Wood/MDF and flush wood paneling:

1. Water-based Varnish System:
  - a. Surface preparation: Waterbourne acrylic sealer 2-3 mils dft. Allow to dry and sand with silicon carbide 280-320 grit sandpaper.
  - b. Finish coats: Two (2) coats: waterbourne acrylic clear finish 3-5 mils dft. Allow to dry fully and scuff sand between all coats. Do not exceed more than two topcoats (3 coats total).

#### B. Wood substrates (stained), non-traffic surfaces, including wood trim and doors.

1. Polyurethane Varnish over Stain System:
  - a. Stain Coat: Stain, semi-transparent, for interior wood, MPI #90.
  - b. First Intermediate Coat: Polyurethane varnish matching topcoat.
  - c. Second Intermediate Coat: Polyurethane varnish matching topcoat.
  - d. Topcoat: Varnish, interior, polyurethane, oil-modified, satin (Gloss Level 4), MPI #57.

END OF SECTION 099300

## SECTION 101100 - VISUAL DISPLAY UNITS

### 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. Visual display board assemblies.
  - 2. Magnetic Marker-Board Panels
  - 3. Tack Board/Strip

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.
  - 2. Include electrical characteristics for motorized units.
- B. Shop Drawings: For visual display units.
  - 1. Include plans, elevations, sections, details, and attachment to other work.
  - 2. Include sections of typical trim members.
- C. Samples for Verification: For each type of visual display unit indicated.
  - 1. Visual Display Panel: Not less than 8-1/2 by 11 inches (215 by 280 mm), with facing, core, and backing indicated for final Work. Include one panel for each type, color, and texture required.
  - 2. Trim: 6-inch- (150-mm-) long sections of each trim profile.
  - 3. Display Rail: 6-inch- (150-mm-) long section of each type.
  - 4. Accessories: Full-size Sample of each type of accessory.
- D. Product Schedule: For visual display units. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain visual display surfaces from single source from single manufacturer.

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.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weather-tight, 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: Verify actual dimensions of construction contiguous with visual display units by field measurements before fabrication.
  - 1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

1.8 WARRANTY

- A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Surfaces lose original writing and erasing qualities.
    - b. Surfaces exhibit crazing, cracking, or flaking.
  - 2. Warranty Period: 50 years
  - 3. Warranty Period: Life of the building.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of visual display unit from single source from single manufacturer.

### 2.2 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: 450 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.

### 2.3 VISUAL DISPLAY BOARD ASSEMBLY (MB-1, MB-2, MB-3)

- 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. Claridge Products and Equipment, Inc.
  - 2. ADP Lemco, Inc.
- B. Visual Display Board Assembly Factory fabricated.
  - 1. Product: Claridge Porcelain Enamel Marker Walls - Porcelain Enamel laminated panels with matched butt joints and steel splines (Basis-of-Design)
  - 2. Face Sheet: LCS<sup>3</sup> Porcelain Enamel Steel Skin
  - 3. Core: 7/16" MDF core
  - 4. Backer: Standard Moisture Barrier Backing
  - 5. Laminations (where required): Shall be hot-type neoprene contact adhesive applied to both surfaces automatically. Each substrate shall have a minimum of 80% covering with 1.5-2.0 dry mils of adhesive. Panel components shall have uniform pressure applied mechanically over entire area. Laminations shall be made by face sheet manufacturer
  - 6. Corners: Square.
  - 7. Size: As indicated on Drawings.
  - 8. Color: As indicated on Drawings
  - 9. Mounting Method: MW2 - LCS Markerwall system with matched butt joints and No. 18 Adhesive
  - 10. Frame: Aluminum J-Trim.
  - 11. Frame depth: To match depth of marker-board.

## VISUAL DISPLAY UNITS

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- C. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, as indicated on approved Shop Drawings. Factory Assembled. Center field panels to be 48" widths to provide factory porcelain edges, outside panels to be cut only on outside edge where covered by J-Trim. Cut edges with chipping are not acceptable at butted joints.

## 2.4 VISUAL DISPLAY BOARD ASSEMBLY (TBD-1, TBD-3)

- 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. Forbo
  2. Claridge Products and Equipment, Inc.
  3. ADP Lemco, Inc.
- B. Visual Display Board Assembly Factory fabricated.
1. Product: 800 Series Tack-Board by Claridge (Basis-of-Design)
  2. Assembly: tack-board with aluminum trim
  3. Corners: Square.
  4. Width: As indicated on Drawings.
  5. Height: 4 feet (122 cm).
  6. Mounting Method: Direct to wall.
  7. Frame: Aluminum Channel trim.
  8. Frame depth: To match depth of tack-board.
- C. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, as indicated on approved Shop Drawings.
- D. Chalk Tray: Manufacturer's standard; continuous.
1. No tray at bottom edge. Magnetic tray at each wall

## 2.5 TACK STRIP ASSEMBLY (TBD-2)

- 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. Forbo
  2. Claridge Products and Equipment, Inc.
  3. ADP Lemco, Inc.
- B. Visual Display Board Assembly Factory fabricated.
1. Product: Forbo Bulletin Board Cord
  2. Assembly: Tack-Board with aluminum trim

3. Corners: Square.
4. Width: 4' Wide Roll
5. Height: As indicated on Drawings.
6. Color: As indicated on Drawings
7. Thickness: 1/4"
8. Mounting Method: Direct glue adhered to properly prepared GWB wall surfaces where indicated. GWB surface to be minimum level 4 finish with primed/sealed surface. Frame: Aluminum angle trim.
9. Frame: All edges to be trimmed with clear satin anodized aluminum J-Trim. PBS Supply Co. #E704 or equal.
10. Frame depth: To match depth of tack-board.

- C. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, as indicated on approved Shop Drawings.

## 2.6 MATERIALS

- A. Porcelain-Enamel Face Sheet: PEI-1002, with face sheet manufacturer's standard two- or three-coat process.
- B. Particleboard: ANSI A208.1, Grade M-1, made with binder containing no urea formaldehyde.
- C. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063.
- D. Adhesives for Field Application: Mildew-resistant, non-staining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by visual display unit manufacturer.
  1. Adhesives shall have a VOC content of 50 g/L or less.

## 2.7 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "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.

## 2.8 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

## VISUAL DISPLAY UNITS

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### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, 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.
- 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 only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.
- C. 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.

#### 3.3 INSTALLATION

- A. General: Install visual display surfaces in locations indicated on Drawings; mounting heights are to be coordinated with the Owner. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- B. Factory-Fabricated Visual Display Board Assemblies: 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.

#### 3.4 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.

### VISUAL DISPLAY UNITS

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- 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 101100

## SECTION 101423 - SIGNAGE

### 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. Room-identification signs.
  - 2. Plaques

#### 1.3 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

#### 1.4 COORDINATION

- A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.
- B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For panel signs.
  - 1. Include fabrication and installation details and attachments to other work.
  - 2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
  - 3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
  - 4. Show sign locations on floor plan.

- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
  - 1. Include representative Samples of available typestyles and graphic symbols.
- D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
  - 1. Room-Identification Signs: Full-size Sample.
- E. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

#### 1.8 FIELD CONDITIONS

- A. Field Measurements: Verify locations of anchorage devices embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

#### 1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Deterioration of finishes beyond normal weathering.
    - b. Deterioration of embedded graphic image.
    - c. Separation or delamination of sheet materials and components.
  - 2. Warranty Period: Five years.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for signs.

### 2.2 SIGNS

- 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. Graffix.
  2. ASI.
  3. InPro Corporation (IPC).
  4. 290 Sign Systems.
- B. Room-Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
1. Laminated-Sheet Sign: face sheet with raised graphics laminated to acrylic backing sheet to produce composite sheet.
    - a. Composite-Sheet Thickness: 0.125 inch (3.18 mm).
    - b. Color(s): As selected by Architect from manufacturer's full range.
  2. Solid Acrylic Sign:
    - a. Sheet Thickness: 3/8".
    - b. Color(s): As selected by Architect from manufacturer's full range.
  3. Sign-Panel Perimeter: Finish edges smooth.
    - a. Edge Condition: Beveled.
    - b. Corner Condition in Elevation: Rounded to radius indicated.
  4. Mounting: Surface mounted to wall or glass with adhesive.
  5. Text and Typeface: Accessible raised characters and Braille typeface as selected by Architect from manufacturer's full range and variable content as scheduled. Finish raised characters to contrast with background color, and finish Braille to match background color.

## 2.3 SIGN MATERIALS

- A. Matte Clear Acrylic Sheet: ASTM D 4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

## 2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required 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.
- B. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch (1.14 mm) thick, with adhesive on both sides.

## 2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
  - 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only 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.

## 2.6 GENERAL FINISH REQUIREMENTS

- A. 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, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

## SIGNAGE

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### 3.2 INSTALLATION

- A. General: 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. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
- B. Room-Identification Signs and Other Accessible Signage: Install in locations on walls according to accessibility standard.
- C. Mounting Methods:
  - 1. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.
- D. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.

### 3.3 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.

### 3.4 SCHEDULE

- A. Reference Signage Schedule in drawings for sign types and signage messages.

END OF SECTION 101423

## SECTION 102600 - WALL AND DOOR PROTECTION

### 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. Corner guards.
- 2. Wall cladding.

- B. Related Requirements:

- 1. Section 087100 "Door Hardware" for metal protective trim units, according to BHMA A156.6, used for armor, kick, mop, and push plates.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.

- B. Detail Drawings: mounting details with the appropriate adhesives for specific project substrates

- C. Samples: For plastic paneling, in manufacturer's standard sizes.

- D. Manufacturer's Installation instruction: Printed Installation instructions

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of wall and door protection product to include in maintenance manuals.

#### 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Corner-Guard Covers: Full-size plastic covers of maximum length equal to **2** < percent of each type, color, and texture of cover installed, but no fewer than four, 48-inch- (1200-mm-) long units.

## 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.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain wall- and door-protection products from single source from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1.

### 2.3 CORNER GUARDS (CG)

- A. Surface-Mounted, Metal Corner Guards: Fabricated as one piece from formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.
  - 1. Manufacturers: Subject to compliance with requirements, provide products from one of the following:
    - a. American Floor Products, Inc.
    - b. Babcock-Davis.
    - c. Balco, Inc.
    - d. Construction Specialties, Inc.
    - e. InPro Corporation (IPC).
    - f. Nystrom.
  - 2. Material: Stainless-steel sheet, Type 304.
    - a. Thickness: Minimum 0.0625 inch (1.6 mm).
    - b. Finish: Directional satin, No. 4.

3. Wing Size: Nominal 1-1/2 by 1-1/2 inches (90 by 90 mm.)
4. Corner Radius: 1/8 inch (3 mm).
5. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes.

B. WALL CLADDING (WC-1)

1. Manufacturers: Basis of Design Inpro Sani-Surface Hygienic Wall Cladding. Subject to compliance with requirements, provide products from one of the following
  - a. Inpro Corporation.
  - b. Altro.
  - c. Marlite.
  - d. Crane Composites.
2. Material: Vinyl: Sani-Surface Hygienic Wall Cladding shall be manufactured from 100% chemical and stain resistant polyvinyl chloride. No plasticizers shall be added (plasticizers may aid in bacterial growth).
3. Accessories: Top caps, inside corners, divider bars and outside corners shall be made of extruded PVC.
4. Finishes: per construction drawings, surface shall have a velvet texture.

2.4 MATERIALS

- A. 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

2.5 FABRICATION

- A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.
- B. Quality: 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.

2.6 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.

WALL AND DOOR PROTECTION

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### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances 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.
  - 1. For wall and door protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
  - 2. Examine areas and conditions in which product will be installed. Complete all finish operations, including painting before beginning installation of materials.
  - 3. Wall surface shall be dry and free from dirt, grease and loose paint.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing wall and door protection.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

#### 3.3 INSTALLATION

- A. Installation Quality: Install wall and door 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. For Wall Cladding:
  - 1. Adhere to substrate with Titebond GREENchoice Fast Grab FRP Construction, a freeze-thaw stable, nonflammable, high strength, water based adhesive that trowels on and allows approximately 20 minutes working time before firming
  - 2. Adhere to substrate with Titebond Advanced Polymer, a freeze-thaw stable, nonflammable, high strength, water based adhesive that trowels on and allows approximately 20 minutes working time before firming.

3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.
- B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 102600

## SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

### 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. Public-use washroom accessories.
  - 2. Childcare accessories.
  - 3. Underlavatory guards.
  - 4. Custodial accessories.
  - 5. Warm-air dryers.
- B. Related Requirements:
  - 1. Section 093013 "Ceramic Tiling" for ceramic toilet and bath accessories.

#### 1.3 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.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.

- B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

- 1. Identify locations using room designations indicated.
  - 2. Identify accessories using designations indicated.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's special warranty.

## 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

## 1.7 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: 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 OWNER-FURNISHED MATERIALS

- A. Owner-Furnished Materials: See owner Furnished Material & Equipment Schedule.

## 2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Source Limitations: Obtain public-use washroom accessories from single source from single manufacturer.
- B. Toilet Tissue (Roll) Dispenser: OFCI:
- C. Paper Towel Dispenser: OFCI:
- D. Waste Receptacle OFCI:
- E. Liquid-Soap Dispenser OFCI:
- F. Grab Bar (GB):

# TOILET, BATH, AND LAUNDRY ACCESSORIES

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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. American Specialties, Inc.
  - b. Bobrick Washroom Equipment, Inc.
  - c. Bradley Corporation.
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
  - a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.
4. Outside Diameter: 1-1/4 inches (32 mm).
5. Configuration and Length: As indicated on Drawings.

G. Seat-Cover Dispenser OFCI:

H. Mirror Unit (MR):

1. Manufacturers: Subject 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 Specialties, Inc.
  - b. Bobrick Washroom Equipment, Inc.
  - c. Bradley Corporation.
2. Frame: Stainless-steel channel.
  - a. Corners: Mitered and mechanically interlocked.
3. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
  - a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
4. Size: As indicated on Drawings.

2.3 CHILDCARE ACCESSORIES

- A. Source Limitations: Obtain childcare accessories from single source from single manufacturer.
- B. Diaper-Changing Station:

1. Manufacturers: Subject 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 Specialties, Inc.
  - b. Diaper Deck & Company, Inc.
  - c. Koala Kare Products.
2. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
  - a. Engineered to support minimum of 250-lb (113-kg) static load when opened.
3. Mounting: Surface mounted, with unit projecting not more than 4 inches (100 mm) from wall when closed.
4. Operation: By pneumatic shock-absorbing mechanism.
5. Material and Finish: HDPE in manufacturer's standard color.
6. Liner Dispenser: Built in.

## 2.4 UNDERLAVATORY GUARDS

### A. Underlavatory Guard As indicated on drawings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Plumberex Specialty Products, Inc.
  - b. Truebro by IPS Corporation.
2. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
3. Material and Finish: Antimicrobial, molded plastic, white.

## 2.5 CUSTODIAL ACCESSORIES

### A. Source Limitations: Obtain custodial accessories from single source from single manufacturer.

### B. Utility Shelf (US):

1. Manufacturers: Subject 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 Specialties, Inc.
  - b. Bobrick Washroom Equipment, Inc.
  - c. Bradley Corporation.
2. Description: With exposed edges turned down not less than 1/2 inch (13 mm) and supported by two triangular brackets welded to shelf underside.
3. Size: 16 inches (406 mm) long by 6 inches (152 mm) deep.
4. Material and Finish: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel, No. 4 finish (satin).

C. Mop and Broom Holder (MBH):

1. Manufacturers: Subject 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 Specialties, Inc.
  - b. Bobrick Washroom Equipment, Inc.
  - c. Bradley Corporation.
2. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
3. Length: 30 inches (914 mm).
4. Hooks: Four.
5. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
6. Material and Finish: Stainless steel, No. 4 finish (satin).
  - a. Shelf: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel.
  - b. Rod: Approximately 1/4-inch- (6-mm-) diameter stainless steel.

2.6 Warm-Air Dryer (Hand Dryer)

A. Source Limitations: Obtain warm-air dryers from single source from single manufacturer

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. World Dryer. Basis of Design: Model A Series/Stock #DA5-974
2. Description: Standard-speed, warm-air hand dryer.
3. Mounting: Surface mounted.
4. Operation: Touch-button activated with timed power cut-off switch.
  - a. Operation Time: 30 to 40 seconds.
5. Cover Material and Finish: Steel, with white enamel finish.
6. Electrical Requirements: 115 V, 20 A, 2300 W.

## 2.7 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch (0.8-mm) minimum nominal thickness unless otherwise indicated.
- B. 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.
- C. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch (0.9-mm) minimum nominal thickness.
- D. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 (Z180) hot-dip zinc coating.
- E. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- F. 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.
- G. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

## PART 3 - EXECUTION

### 3.1 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.

### 3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION 102800

## SECTION 122113 – HORIZONTAL LOUVER BLINDS

### 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. Horizontal louver blinds with aluminum slats.

- B. Related Requirements:

- 1. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting horizontal louver blinds and accessories.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings: For horizontal louver blinds, include fabrication and installation details.

- C. Samples: For each exposed product and for each color and texture specified, 12 inches (300 mm) long.

- D. Samples for Initial Selection: For each type and color of horizontal louver blind.

- 1. Include Samples of accessories involving color selection.

- E. Samples for Verification: For each type and color of horizontal louver blind indicated.

- 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.

- F. Product Schedule: For horizontal louver blinds. Use same designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For horizontal louver blinds to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- 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. Horizontal Louver Blinds: 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.

1.6 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Provide horizontal louver blinds with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
  - 1. Flame-Resistance Ratings: Passes NFPA 701.

1.7 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.

1.8 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.

1.9 WARRANTY

- A. Provide two (2) year warranty on materials and installation.

HORIZONTAL LOUVER BLINDS

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## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain horizontal louver blinds from single source from single manufacturer.

### 2.2 HORIZONTAL LOUVER BLINDS, ALUMINUM SLATS (HLB-1)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Levolor; Riviera or comparable product by one of the following:

1. CACO Inc. Window Fashions.
2. Hunter Douglas
3. Springs Window Fashions;

- B. Slats: Aluminum; alloy and temper recommended by producer for type of use and finish indicated; with crowned profile and radius corners.

1. Width: 1 inch (25 mm).
2. Thickness: Not less than 0.008 inch (0.20 mm).
3. Spacing: Manufacturer's standard.
4. Finish: Ionized antistatic, dust-repellent, baked polyester finish.
5. Features:

- a. Lift-Cord Rout Holes: Minimum size required for lift cord and located near back (outside) edge of slat to maximize slat overlap and minimize light gaps between slats.

- C. Headrail: Formed steel or extruded aluminum; long edges returned or rolled. Headrails fully enclose operating mechanisms on three sides.

1. Capacity: One blind(s) per headrail unless otherwise indicated.
2. Ends: Capped or plugged.
3. Manual Lift Mechanism:
  - a. Lift-Cord Lock: Variable; stops lift cord at user-selected position within blind full operating range.
  - b. Operator: Extension of lift cord(s) through lift-cord lock mechanism to form cord pull.
4. Manual Tilt Mechanism: Enclosed worm-gear mechanism and linkage rod that adjusts ladders.
  - a. Tilt: Full.
  - b. Operator: Clear-plastic wand.

## HORIZONTAL LOUVER BLINDS

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- c. Over-Rotation Protection: Manufacturer's detachable operator or slip clutch to prevent over rotation of gear.
    - 5. Manual Lift-Operator and Tilt-Operator Lengths: Manufacturer's standard.
    - 6. Manual Lift-Operator and Tilt-Operator Locations: Right side or left side of headrail, dependent on window access, unless otherwise indicated.
    - 7. Integrated Headrail/Valance: Manufacturer's standard.
  - D. Bottom Rail: Formed-steel or extruded-aluminum tube that secures and protects ends of ladders and lift cords and has plastic- or metal-capped ends.
    - 1. Type: Top contoured to match crowned shape of slat.
  - E. Lift Cords: Manufacturer's standard braided cord.
  - F. Ladders: Evenly spaced across headrail at spacing that prevents long-term slat sag.
    - 1. Type: Braided polyester jacket cord.
  - G. Valance: Manufacturer's standard.
  - H. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.
    - 1. Type: Overhead.
    - 2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by blind manufacturer for weight and size of blind.
  - I. Side Channels and Perimeter Light Gap Seals: Manufacturer's standard.
  - J. Colors, Textures, Patterns, and Gloss:
    - 1. Slats: As indicated in Color and Materials Schedule in drawings or if not indicated, as selected by Architect from full range of industry colors.
    - 2. Components: Provide rails, cords, ladders, and materials exposed to view matching or coordinating with slat color unless otherwise indicated.
- 2.3 HORIZONTAL LOUVER BLIND FABRICATION
- A. Product Safety Standard: Fabricate horizontal louver blinds to comply with WCMA A 100.1 including requirements for corded, flexible, looped devices; lead content of components; and warning labels.
  - B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which blind is installed less 1/4 inch (6 mm) per side or 1/2 inch (13 mm) total, plus or minus 1/8 inch (3.1 mm). Length equal to head-to-sill dimension of opening in which blind is installed less 1/4 inch (6 mm), plus or minus 1/8 inch (3.1 mm).
- C. Concealed Components: Non-corrodible or corrosion-resistant-coated materials.
  1. Lift-and-Tilt Mechanisms: With permanently lubricated moving parts.
- D. Mounting and Intermediate Brackets: Designed for removal and reinstallation of blind without damaging blind and adjacent surfaces, for supporting blind components, and for bracket positions and blind placement indicated.
- E. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to brackets and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.
- F. Color-Coated Finish:
  1. Metal: For components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install horizontal louver blinds level and plumb, aligned and centered on openings, and aligned with adjacent units according to manufacturer's written instructions.
  1. Install mounting and intermediate brackets to prevent deflection of headrails.
  2. Install with clearances that prevent interference with adjacent blinds, adjacent construction, and operating hardware of glazed openings, other window treatments, and similar building components and furnishings.

3.3 ADJUSTING

- A. Adjust horizontal louver blinds to operate free of binding or malfunction through full operating ranges.

3.4 CLEANING AND PROTECTION

- A. Clean horizontal louver blind surfaces after installation according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer that ensures that horizontal louver blinds 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 SCHEDULE

- A. Provide horizontal louver blinds at Admin sidelites, where noted on Drawings.

END OF SECTION 122113

## SECTION 122413 - ROLLER WINDOW SHADES

### 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. Manually operated roller shades with single rollers.
  - 2. Motor-operated roller shades with single rollers.

- B. Related Requirements:

- 1. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
  - 2. Section 079200 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

- B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

- C. Samples for Initial Selection: For each type and color of shadeband material.

- 1. Include Samples of accessories involving color selection.

- D. Samples for Verification: For each type of roller shade.

- 1. Shadeband Material: Not less than 10 inches (250 mm) square. Mark interior face of material if applicable.
  - 2. Roller Shade: Full-size operating unit, not less than 16 inches (400 mm) wide by 36 inches (900 mm) long for each type of roller shade indicated.
  - 3. Installation Accessories: Full-size unit, not less than 10 inches (250 mm) long.

- E. Product Schedule: For roller shades. Use same designations indicated on Drawings.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of shadeband material.
- C. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than two units.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

#### 1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction 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 roller shades 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.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain roller shades from single source from single manufacturer.

### 2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS (SHADE-1)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide MechoShade Systems, Inc., EuroTwill or comparable product by one of the following:
1. Draper Inc.
  2. Hunter Douglas Contract
- B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
1. Bead Chains: Stainless steel.
    - a. Loop Length: Full length of roller shade.
    - b. Limit Stops: Provide upper and lower ball stops.
    - c. Chain-Retainer Type: Chain tensioner, sill mounted.
  2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.
    - a. Provide for shadebands that weigh more than 10 lb (4.5 kg) or for shades as recommended by manufacturer, whichever criterion is more stringent.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
1. Roller Drive-End Location: Right or left side of interior face of shade as required for access.
  2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
  3. Shadeband-to-Roller Attachment: Removable spline fitting into integral channel in tube.
- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

- E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- F. Shadebands:
  - 1. Shadeband Material: Light-filtering fabric at exterior windows, light-blocking at interior locations.
  - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
    - a. Color and Finish: As indicated in Color and Materials Schedule in drawings or if not indicated, as selected by Architect from full range of industry colors.
- G. Installation Accessories:
  - 1. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.

## 2.3 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
  - 1. Source: Roller shade manufacturer.
  - 2. Type: Vinyl coated polyester.
  - 3. Orientation on Shadeband: Up the bolt.
  - 4. Openness Factor: 3 percent.
  - 5. Color: As indicated in Color and Materials Schedule in drawings or if not indicated, as selected by Architect from full range of industry colors.

## 2.4 ROLLER SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):
  - 1. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:

1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, locations of connections to building electrical system, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 ROLLER SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
- B. Electrical Connections: Connect motor-operated roller shades to building electrical system.
- C. Roller Shade Locations: At exterior windows.
- D. Mount to window header per manufacturer's typical details. Align to top of mullion UNO.

#### 3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

#### 3.4 CLEANING AND PROTECTION

- A. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades 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 motor-operated roller shades.

3.6 SCHEDULE

- 1. All exterior windows to receive SHADE-1. See drawings.

END OF SECTION 122413

## SECTION 123216 - MANUFACTURED PLASTIC-LAMINATE-FACED CASEWORK

### 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. Plastic-laminate-faced cabinets of stock design
2. Plastic-laminate countertops
3. Solid-surfacing-material countertops
4. Cabinet hardware.

- B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking for anchoring casework.
2. Section 096513 "Resilient Base and Accessories" for resilient base applied to plastic-laminate-faced casework.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
- B. Keying Conference: Conduct conference at Project site. Incorporate keying conference decisions into final keying requirements.

#### 1.4 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that casework can be supported and installed as indicated.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show fabrication details, including types and locations of hardware. Show installation details, including field joints and filler panels. Indicate manufacturer's catalog numbers for casework.
  - 1. Indicate locations of hardware and keying of locks.
  - 2. Indicate locations of blocking and reinforcements required for installing casework.
  - 3. Include details of support framing system.
  - 4. Indicate locations of and clearances from adjacent walls, doors, windows, other building components.
- C. Keying Schedule: Include schematic keying diagram and index each key set to unique designations that are coordinated with the Contract Documents.
- D. Samples: For cabinet finishes.
- E. Samples for Verification: 8-by-10-inch (200-by-250-mm) Samples for each type of finish and the following:
  - 1. One full-size finished base cabinet complete with hardware, doors, and drawers.
  - 2. One full-size finished wall cabinet complete with hardware, doors, and adjustable shelves.
  - 3. Maintain full-size Samples at Project site during construction in an undisturbed condition as a standard for judging the completed Work. Unless otherwise indicated, approved sample units may become part of the completed Work if in undisturbed condition at time of Substantial Completion. Notify Architect of their exact locations.
  - 4. Section of countertop showing top, front edge, and backsplash construction.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.
- C. Sample Warranty: For special warranty.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: a certified participant in AWI's Quality Certification Program.
- B. Source Limitations: Obtain manufactured wood casework from single source from single manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver casework only after painting, utility roughing-in, and similar operations that could damage, soil, or deteriorate casework have been completed in installation areas. If casework must be stored in other than installation areas, store only in areas where environmental conditions meet requirements specified in "Project Conditions" Article.
- B. Keep finished surfaces covered with polyethylene film or other protective covering during handling and installation.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install manufactured wood casework until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 43 and 70 percent during the remainder of the construction period.
- B. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.
- C. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Delamination of components or other failures of glue bond.
    - b. Warping of components.
    - c. Failure of operating hardware.
  - 2. Warranty Period: Five years.

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:
  - 1. Manufactured Casework:

MANUFACTURED PLASTIC-LAMINATE-FACED CASEWORK

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- a. LSI Corporation of America; a Sagas International company.
- b. TMI Systems Design Corporation.
- c. Skagit Architectural Millwork.
- d. Northwest Millwork

B. Source Limitations: Obtain plastic-laminate-faced cabinets from single manufacturer.

## 2.2 CASEWORK, GENERAL

- A. Educational casework shall meet or exceed the requirements for Architectural Woodwork Institute Quality Standards Section 400B and 1600B for custom grade flush overlay constructed casework. Specific requirements set forth within this specification shall take precedence over the AWI Standard.
- B. Product Designations: Drawings indicate sizes, configurations, and finish materials of manufactured plastic-laminate-faced cabinets by referencing designated manufacturer's catalog numbers. Other manufacturers' casework of similar sizes and door and drawer configurations, of same finish materials, and complying with the Specifications may be considered. See Section 016000 "Product Requirements."
  1. Designated Manufacturer: LSI Corporation of America; a Sagas International company.

## 2.3 MATERIALS

- A. High Pressure Plastic Laminate (PLAM-1 – PLAM-4)
  1. Plastic laminate shall meet standard of NEMA LD3-1985, and shall be of the following thickness:
    - a. Balancing Sheet: 0.020 inch.
    - b. Horizontal Surfaces: 0.050 inch.
    - c. Vertical Surfaces: 0.028 inch.
    - d. Cabinet Liner: Pressure fused laminate bonded to substrate. Color shall be manufacturer's standard almond, gray or white as selected by Architect.
  2. Manufacturers: Products indicated in Drawings are to establish the quality and aesthetic desired for this Project. Other manufacturers listed below are also acceptable, provided that they manufacture products in color and texture to match that which is selected and specified:
    - a. Formica.
    - b. Abet Laminati.
    - c. Nevamar.
    - d. Laminart.
    - e. Wilsonart.

3. Color Selection: As indicated in Color and Materials Schedule in drawings.
4. Lead Times: Allow for 4-6 weeks lead time for premium laminates
5. Edging: Provide T-molding at all exposed edges of cabinets, or cubbies UNO. T-molding to match existing color, field verify black, UNO.

B. Hardware:

1. Hinges:
  - a. Heavy duty, five knuckle 2-3/4-inch institutional type hinge. Mill ground, hospital tip, tight pin feature with all edges eased. Hinge to be full wrap around type of tempered steel 0.095 inch thick. Each hinge to have minimum nine screws, #7, 5/8 inch FHMS to assure positive door attachment.
  - b. One pair per door to 36 inch height. One and one-half pair over 37 inches in height. Two pairs on doors wider than 24 inches or for doors 73 inches or higher. Hinge to accommodate 13/16-inch thick laminated door, and allow 270 degree swing.
  - c. Finish to be dull chrome for fixed cabinetry.
2. Pulls: Solid aluminum wire pulls, fastened from back with two screws. Provide two pulls for drawers more than 24 inches (600 mm) wide.
  - a. Color: As selected by Architect from manufacturer's full range of colors.
3. Drawer Slides:
  - a. Provide Knap & Vogt 8400, 4100, 6400; Fulterer FR 5000 or Accuride 3832C, 3834C, 3832CSC, 3834CSC, 2632.
  - b. File Drawer Accessory: Knap & Vogt No. 476 follower and track assembly, or Pendaflex rack.
  - c. Paper Storage Drawers: Full extension, 3-part progressive opening slide, minimum 100 lb., zinc plated or epoxy coated at manufacturer's option.
4. Catches:
  - a. 7 lb. magnetic catch for base and wall cabinets. Provide two 7 lb. pulls at each tall cabinet door. Catch housing to be molded in color to match cabinet interior.
  - b. Where cabinet locks are indicated on pair of doors, provide both magnetic catch and thumb latch.
  - c. Do not provide catch at sliding drawers.
5. Adjustable Shelf Supports: To be twin pin design with anti tip-up shelf restraints for both 3/4-inch and 1-inch shelves. Design to include keel to retard shelf slide-off, and slot for ability to mechanically attach shelf to clip. Load rating to be minimum of 300 lbs. each support without failure. Cabinet interior sides shall be flush, without shelf system permanent projection.
6. Wardrobe Rod: To be 1-1/16-inch rod supported by flanges.
7. Coat Hooks:

- a. Coat & Hat Hook: Mounted at bottom of cubbies as shown; Ives 572 Aluminum Clear Coat.
- 8. Locks: To be disc tumbler lock keyed alike and master keyed. Dull chrome finish.
  - a. Hinged doors and drawers Olympus - 100DR, 200DW.
  - b. Refer to Casework General Notes for location of locks.
- 9. Grommet: Provide as shown, minimum 2-1/2-inch diameter to allow electrical wiring to extend through tops. Molded grommets and matching caps with slot for wire passage. Color/Finish: As selected by Architect from full range of industry colors.
- C. Detailed Requirements for Cabinet Construction:
  - 1. Sub-Base:
    - a. Cabinet Subbase: All fixed under-counter and tall units shall have an individual factory-applied base, separate and continuous (no cabinet body sides-to-floor), 3/4-inch-thick water resistant exterior grade plywood with concealed fastening to cabinet bottom. Ladder-type construction, of front, back and intermediates, to form a secure and level platform to which cabinets attach. Base is nominal 4 inches high unless shown otherwise. Panel to the floor or separate particle board base is unacceptable.
    - b. No levelers are permitted.
  - 2. Cabinet Top and Bottom:
    - a. Base and tall cabinet bottoms to be natural plywood, premium grade and sanded smooth, painted on concealed side as indicated on drawings.
    - b. Solid sub-top to be 3/4 inch. Furnish for all base and tall cabinets. Stretchers are unacceptable.
    - c. Wall cabinet bottoms and tops are 3/4-inch-thick.
    - d. Exterior exposed wall cabinet bottoms to be pressure fused laminate both sides. Assembly devices to be concealed on bottom side of wall cabinets.
  - 3. Cabinet Ends:
    - a. Solid plywood, premium grade with radiused on edges, sanded smooth finish. Doors to have eased corners, with a radius of 6" diameter on all four sides.
    - b. Exposed exterior cabinet ends to be natural grain of plywood, radiused and sanded smooth.
    - c. Exposed edges to be natural plywood with radius edges sanded smooth.
  - 4. Fixed and Adjustable Shelves:
    - a. Pressure fused laminated plywood two sides. Leading exposed edge of shelves to be edged with 3 mm ABS in color specified in Paragraph 2.3.C above.

- b. Thickness: 3/4-inch standard shelving to be maximum 29 inches wide. One-inch shelving is required for shelves 30 inches wide and over.
  - c. Thickness of shelves at all widths of open cabinets: 1 inch.
5. Cabinet Backs:
- a. Standard cabinet back to be 1/4-inch thick, prefinished hardboard. Wall and tall cabinets are provided with a 1" x 1-3/4" mounting strip used to secure the cabinet to the wall. Exposed back on fixed or moveable cabinets is 3/4 inch particleboard with the exterior surface finished in GP28 laminate as selected.
6. Door and Drawer Fronts:
- a. Plastic laminated doors and drawer fronts to be 13/16 inch thick for all hinged and sliding doors. Core material to be 3/4-inch-thick, plywood bonded on exterior with wood veneer sheet on both interior and exterior faces. Drawer fronts and hinged doors are to 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. Radius edges of drawer fronts 6" diameter.
  - b. Exposed edges to be radius to expose the plywood grain, sanded smooth. Corners to be machine-radiused and buffed to a consistent 3/4" radius. Both outer and inner edges of exposed edge to be machine-radiused and buffed for consistent profile.
7. Drawers:
- a. Drawer fronts shall be applied to separate drawer body component sub-front. Secure drawer fronts to drawer body sub-front utilizing both glued and mechanical means of attachment.
  - b. Sides and back of drawers to be 1/2-inch thick pressure fused laminated fiberboard; sub-front same, to be 1/2-inch thick.
  - c. Exposed top edge to be 1 mm ABS, in color selected from manufacturer's standards.
  - d. Drawer bottom is plywood, 1/2-inch thick, laminated with thermally fused melamine, screwed directly to the bottom edges of the drawer box, to provide a rigid platform. Drawer bottom less than 1/2-inch thick will not be permitted.
  - e. The same 1/2-inch-thick plywood and platform construction detail is used for paper storage drawers and also include an angle retaining bar at the rear of each drawer.
  - f. All drawers shall have roller guides as specified.
8. Vertical and Horizontal Dividers: Tempered hardboard 1/4-inch thick, smooth both faces. Secure in cabinet with molded plastic clips.
9. ADA-Americans with Disabilities Act Requirements: The following special requirements shall be met, where specifically indicated on architectural plans as "ADA," or by General Note. To be in compliance with Federal Register Volume 56, No. 144, Rules and Regulations:

- a. Countertop Height: With or without cabinet below, not to exceed a height of 34 inches A.F.F., (Above Finished Floor), at a surface depth of 24 inches.
- b. Kneespace Clearance: Minimum 27 inches A.F.F., and 30 inches clear span width.
- c. 12 inch Deep Shelving, Adjustable or Fixed: Not to exceed a range from 9 inches A.F.F. to 54 inches A.F.F.
- d. Sink Cabinet Clearances: In addition to 9a., b. above, upper kneespace frontal depth to be no less than 11 inches, at a point 9 inches A.F.F., and as further described in Volume 56, Section 4.19.

D. Countertops, Typical:

1. High pressure plastic laminate bonded to 1-inch-thick plywood core except countertops with sinks. Underside to be properly balanced with heavy gauge backing sheet. Unless noted otherwise, edges to be 3 mm ABS. Provide continuous tops for counter type cabinets fixed in a line. No joints closer than 24 inches either side of sink cutout. Countertops with sinks shall have post formed tops, fabricated with Marine Grade plywood and have all edges of all cutouts sealed with a color-toned, water-resistant sealer.
2. Quality Standard: Comply with AWS Section 11 requirements for countertops.
3. Grade: Custom.

E. Hanging Rods and Shelf Supports: Refer to Details.

F. Workmanship:

1. All exposed exterior cabinet surfaces to be high pressure plastic laminate, colors as specified. Laminate surface/backer to core under controlled conditions, by approved and regulated laminating methods to assure a premium lamination. Natural-setting adhesives that cure through chemical reaction are required. Methods requiring heat are not allowed; "contact" methods of laminating are not allowed.
2. Cabinet parts shall be accurately machined and bored for premium grade quality joinery construction utilizing automatic machinery to insure consistent sizing of modular components.
3. End panels shall be doweled to receive bottom and top.
4. All cases shall be square, plumb and true.
5. Provide removable back panels and closure panels for plumbing access.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

- C. Verify site dimensions of cabinet locations in building prior to fabrication.

### 3.2 CASEWORK INSTALLATION

- A. Install plumb, level, true and aligned with no distortions. Shim as required, using concealed shims. Where casework abuts other finished work, scribe and apply filler strips for accurate fit with fasteners concealed where practicable.
- B. Base Cabinets: Set cabinets straight, plumb, and level. Adjust sub-tops within 1/16 inch of a single plane. Fasten each individual cabinet to floor at toe space with fasteners spaced 24 inches on center. Bolt continuous cabinets together. Secure individual cabinets with not less than 2 fasteners into floor where they do not adjoin other cabinets.
  - 1. Where required, assemble units into one integral unit with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch.
- C. Wall Cabinets: Securely fasten to solid supporting material and not to lath or wallboard. Anchor, adjust, and align wall cabinets as specified for base cabinets.
  - 1. Reinforcement of stud walls to support wall mounted cabinets will be accomplished during wall erection by trade involved; however, indicated accurate location and sizing of reinforcement is responsibility of casework installer.
- D. Install hardware uniformly and precisely after final finishing is complete. Set hinges snug and flat in mortises unless otherwise indicated. Turn screws to flat in mortises unless otherwise indicated. Turn screws to flat seat. Adjust and align hardware so that moving parts operate freely and contact points meet accurately. Allow for final field adjustment after installation.
- E. Adjust casework and hardware so that doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

### 3.3 INSTALLATION OF TOPS

- A. Field Jointing: Where practicable, make in same manner as factory jointing using dowels, splines, adhesives, and fasteners recommended by manufacturer. Locate field joints as shown on accepted shop drawings, factory prepared so there is no job site processing of top and edge surfaces.
- B. Fastenings: Use concealed clamping devices for field joints located within 6 inches of front, at back edges, and at intervals not exceeding 24 inches. Tighten in accordance with manufacturer's instructions to exert a constant, heavy clamping pressure at joints.
  - 1. Secure tops to cabinets with "Z" type fasteners or equivalent, using 2 or more fasteners at each front, end, and back.

- C. Abut top and edge surfaces in one true plane, with internal supports placed to prevent any deflection. Provide flush hairline joints in top units using clamping devices.
  - 1. Where necessary to penetrate top with fasteners, countersink heads approximately 1/8 inch and plug hole flush with material equal in chemical resistance, color, hardness, and texture to top surface.
- D. Abut top and edge surfaces in one true plane, with internal supports placed to prevent any deflection. At material joints, use manufacturer's recommended adhesives and holding devices to provide joint widths not more than 1/16 inch wide at any location, completely filled and flush with abutting edges.
- E. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
  - 1. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
- F. Provide holes and cutouts as required for mechanical and electrical service fittings.
- G. Carefully dress joints smooth, remove any surface scratches, clean and polish entire surface.
- H. Provide scribe moldings for closures at junctures of top, curb, and splash with walls as recommended by manufacturer for materials involved. Use chemical resistant, permanently elastic sealing compound where recommended by manufacturer.
- I. Provide locks at all cabinet drawers and doors.

### 3.4 INSTALLATION OF SINKS

- A. Set top edge of sink unit in manufacturer's recommended chemical resistant sealing compound and firmly secure to produce a tight and fully leakproof joint. Adjust sink and securely support to prevent movement.

### 3.5 INSTALLATION OF ACCESSORIES

- A. Install accessories in accordance with approved location drawings and manufacturer's installation recommendations. Turn screws to a flat seat; do not drive. Adjust moving parts to operate freely and smoothly without binding.

### 3.6 ADJUSTING

- A. Repair or remove and replace defective work, as directed by Architect upon completion of installation.

- B. Adjust doors, drawers, hardware, fixtures and other moving or operating parts to function smoothly.

### 3.7 CLEANING

- A. Repair or remove and replace defective work as directed on completion of installation.
- B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- C. Protection: Provide 6 mil plastic or other suitable water resistant covering over countertop surfaces. Tape to underside of countertop at minimum of 4 feet on center. Protect installed casework and fittings from damage by work of other trades.

END OF SECTION 123216

## SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

### 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. Piping materials and installation instructions common to most piping systems.
  - 2. Mechanical sleeve seals.
  - 3. Sleeves.
  - 4. Escutcheons.

#### 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical 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 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 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.

### PART 2 - PRODUCTS

#### 2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.

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- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

## 2.2 JOINING MATERIALS

- A. Refer to individual Division 21 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. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

## 2.3 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.

## 2.4 SLEEVES

- A. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

## 2.5 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.

## 2.6 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21 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. Do not run sprinkler piping below or through skylight openings.
- 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 free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install escutcheons for penetrations of walls, ceilings, and floors.
- K. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

- L. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
  - 2. 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.
- M. 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 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.
- N. 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.
- O. Verify final equipment locations for roughing-in.
- P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### 3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 21 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. 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.
- E.     Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

END OF SECTION 210500

SECTION 210548 – VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION 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. This Section includes the following:

- 1. Restraining braces.
- 2. Seismic joints.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
  - 1. Site Class as Defined in the IBC: D
  - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: IV Occupancy
    - a. Component Importance Factor: 1.5.
    - b. Component Response Modification Factor: Refer to ASCE standard 7-10, Chapter 13.
  - 3. Component Amplification Factor: Refer to ASCE standard 7-10, Chapter 13.

1.5 SUBMITTALS

- A. Delegated-Design Submittal: For vibration isolation and seismic-restraint calculations and details indicated to comply with performance requirements and design criteria, including

analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

## 1.6 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC and NFPA 13 unless requirements in this Section are more stringent.
- B. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage, 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 not available, 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 SEISMIC-RESTRAINT DEVICES

- A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
  - 1. 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 will be subjected.
- B. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- C. 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. Minimum length of eight times diameter.

## PART 3 - EXECUTION

### 3.1 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127 and NFPA 13.

## VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

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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.
- B. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- C. 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.
- D. Seismic joints: Install at building seismic joints in accordance with manufacturer's recommendations.
- E. 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
  5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

END OF SECTION 210548

## SECTION 211000 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections:
  - 1. Section 210500 "Common Work Results For Fire Suppression."
  - 2. Section 210548 "Vibration and Seismic Controls For Fire Suppression Piping and Equipment."
  - 3. Section 283111 "Digital, Addressable Fire-Alarm System" for connections to alarm devices.

#### 1.2 SUMMARY

- A. This Section includes the following fire-suppression piping inside the building:
  - 1. Wet-pipe sprinkler systems.

#### 1.3 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

#### 1.4 DEFINITIONS

- A. Standard Weight Pipe: Schedule 40.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.
- B. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.
  - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.

2. Sprinkler Occupancy Hazard Classifications:

- a. As indicated. Final Hazard Classification shall be determined by installing Contractor with approval of the AHJ.

- C. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13 and ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

1.6 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, prior to approval from AHJ, for engineering and architectural review. Also provide one set of shop drawings with AHJ approval.
- C. Operation and Maintenance data.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test (by contractor).
  1. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
  1. NFPA 13, "Installation of Sprinkler Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

## 2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M,. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 40, Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 40. Pipe ends may be factory or field formed to match joining method.
- C. Schedule 10 Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
- D. Grooved-End, Steel-Pipe Appurtenances:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International, Inc.
    - b. Tyco Fire & Building Products LP.
    - c. Victaulic Company.
  - 2. Pressure Rating: 175 psig minimum.
  - 3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
  - 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

## 2.3 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint.
- F. Grooved-Joint, Copper-Tube Appurtenances:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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- a. Victaulic Company.
2. Grooved-End, Copper Fittings: ASTM B 75 copper tube or ASTM B 584, bronze castings.
3. Grooved-End-Tube Couplings: To fit copper-tube dimensions, with design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

## 2.4 SPRINKLER SPECIALTY FITTINGS

- A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.
- B. Outlet Specialty Fittings:
  1. Mechanical-T and -Cross Fittings: Not allowed.
  2. Snap-On and Strapless Outlet Fittings: Not allowed.
- C. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
  1. Manufacturers:
    - a. Fire-End and Croker Corp.
    - b. Viking Corp.
- D. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.
  1. Manufacturers:
    - a. Elkhart Brass Mfg. Co., Inc.
    - b. Fire-End and Croker Corp.
    - c. Potter-Roemer; Fire-Protection Div.
- E. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
  1. Manufacturers:
    - a. AGF Manufacturing Co.
    - b. G/J Innovations, Inc.
    - c. Triple R Specialty of Ajax, Inc.
- F. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

1. Manufacturers:

- a. CECA, LLC.
- b. Merit.

2.5 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

B. Butterfly Valves: UL 1091.

1. NPS 2 and Smaller: Bronze body with threaded ends.

a. Manufacturers:

- 1) Global Safety Products, Inc.
- 2) Milwaukee Valve Company.

2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged ends.

a. Manufacturers:

- 1) Global Safety Products, Inc.
- 2) McWane, Inc.; Kennedy Valve Div.
- 3) Mueller Company.
- 4) NIBCO.
- 5) Pratt, Henry Company.

C. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged ends.

1. Manufacturers:

- a. AFAC Inc.
- b. American Cast Iron Pipe Co.; Waterous Co.
- c. Clow Valve Co.
- d. Crane Co.; Crane Valve Group; Crane Valves.
- e. Crane Co.; Crane Valve Group; Jenkins Valves.
- f. Firematic Sprinkler Devices, Inc.
- g. Globe Fire Sprinkler Corporation.
- h. Hammond Valve.
- i. Matco-Norca, Inc.
- j. McWane, Inc.; Kennedy Valve Div.
- k. Mueller Company.
- l. NIBCO.
- m. Potter-Roemer; Fire Protection Div.
- n. Reliable Automatic Sprinkler Co., Inc.

- o. Stockham.
- p. United Brass Works, Inc.
- q. Venus Fire Protection, Ltd.
- r. Watts Industries, Inc.; Water Products Div.

D. Gate Valves: UL 262, OS&Y type.

1. NPS 2 and Smaller: Bronze body with threaded ends.

a. Manufacturers:

- 1) Crane Co.; Crane Valve Group; Crane Valves.
- 2) Hammond Valve.
- 3) NIBCO.
- 4) United Brass Works, Inc.

2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.

a. Manufacturers:

- 1) Clow Valve Co.
- 2) Crane Co.; Crane Valve Group; Crane Valves.
- 3) Crane Co.; Crane Valve Group; Jenkins Valves.
- 4) Hammond Valve.
- 5) Milwaukee Valve Company.
- 6) Mueller Company.
- 7) NIBCO.
- 8) Red-White Valve Corp.
- 9) United Brass Works, Inc.

E. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.

- 1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch.
- 2. NPS 2 (DN 50) and Smaller: Ball or butterfly valve with bronze body and threaded ends.

a. Manufacturers:

- 1) Milwaukee Valve Company.
- 2) NIBCO.

3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged ends.

a. Manufacturers:

- 1) McWane, Inc.; Kennedy Valve Div.
- 2) Milwaukee Valve Company.

3) NIBCO.

2.6 UNLISTED GENERAL-DUTY VALVES

- A. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.
- B. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.
- C. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.7 SPECIALTY VALVES

- A. Sprinkler System Control Valves: UL listed or FMG approved, cast- or ductile-iron body with flanged ends, and 175-psig minimum pressure rating.
  - 1. Manufacturers:
    - a. AFAC Inc.
    - b. Firematic Sprinkler Devices, Inc.
    - c. Globe Fire Sprinkler Corporation.
    - d. Reliable Automatic Sprinkler Co., Inc.
    - e. Venus Fire Protection, Ltd.
    - f. Viking Corp.
  - 2. Alarm Check Valves: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
    - a. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
    - b. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
- B. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.
  - 1. Manufacturers:
    - a. AFAC Inc.
    - b. Reliable Automatic Sprinkler Co., Inc.
    - c. Tyco Fire & Building Products LP.

## 2.8 SPRINKLERS

- A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating.
- B. Manufacturers:
  - 1. AFAC Inc.
  - 2. Firematic Sprinkler Devices, Inc.
  - 3. Globe Fire Sprinkler Corporation.
  - 4. Reliable Automatic Sprinkler Co., Inc.
  - 5. Venus Fire Protection, Ltd.
  - 6. Viking Corp.
- C. Automatic Sprinklers: With heat-responsive element complying with the following:
  - 1. UL 199, for nonresidential applications.
  - 2. UL 1767, for early-suppression, fast-response applications.
- D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
- E. Sprinkler types, features, and options as follows:
  - 1. Concealed ceiling sprinklers, including cover plate.
  - 2. Flush ceiling sprinklers, including escutcheon.
  - 3. Pendent sprinklers.
  - 4. Quick-response sprinklers.
  - 5. Recessed sprinklers, including escutcheon.
  - 6. Sidewall sprinklers.
  - 7. Upright sprinklers.
- F. Sprinkler Finishes: Chrome plated, bronze, and painted.
- G. Special Coatings: Wax, lead, and corrosion-resistant paint.
- H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
  - 1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
  - 2. Sidewall Mounting: Chrome-plated steel, one piece, flat.
- I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

## 2.9 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.

- B. Water-Motor-Operated Alarm: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 10-inch- diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 inlet and NPS 1 drain connections.

1. Manufacturers:

- a. AFAC Inc.
- b. Firematic Sprinkler Devices, Inc.
- c. Globe Fire Sprinkler Corporation.
- d. Reliable Automatic Sprinkler Co., Inc.
- e. Viking Corp.

- C. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

1. Manufacturers:

- a. ADT Security Services, Inc.
- b. ITT McDonnell & Miller
- c. Potter Electric Signal Company.
- d. System Sensor.
- e. Viking Corp.
- f. Watts Industries, Inc.; Water Products Div.

- D. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

1. Manufacturers:

- a. McWane, Inc.; Kennedy Valve Div.
- b. Potter Electric Signal Company.
- c. System Sensor.

## 2.10 PRESSURE GAGES

A. Manufacturers:

1. AGF Manufacturing Co.
2. AMETEK, Inc.; U.S. Gauge.
3. Brecco Corporation.
4. Dresser Equipment Group; Instrument Div.
5. Marsh Bellofram.
6. WIKA Instrument Corporation.

- B. Description: UL 393, 3-1/2- to 4-1/2-inch diameter, dial pressure gage with range of 0 to 250 psig minimum.
  - 1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
  - 2. Air System Piping: Include retard feature and caption "AIR" or "AIR/WATER" on dial face.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

### 3.2 PIPING APPLICATIONS, GENERAL

- A. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- B. Underground Service-Entrance Piping: Ductile-iron, push-on-joint pipe and fittings and restrained joints.

### 3.3 SPRINKLER SYSTEM PIPING APPLICATIONS

- A. NPS 2-1/2 and Smaller shall be one of the following:
  - 1. Schedule 30 or thinwall: black-steel pipe with plain ends; steel welding fittings; and welded joints.
  - 2. Schedule 30 or thinwall: black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  - 3. Copper Type "L" pipe with soldered fittings.
- B. NPS 3 and Larger shall be one of the following:
  - 1. Schedule 30 or thinwall: black-steel pipe with plain ends; steel welding fittings; and welded joints.
  - 2. Schedule 30 or thinwall: black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  - 3. Schedule 30 or thinwall: black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

### 3.4 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  - 1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13 and NFPA 14.
    - a. Shutoff Duty: Use butterfly or gate valves.
  - 2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13 and NFPA 14.
    - a. Shutoff Duty: Use butterfly or gate valves.
    - b. Throttling Duty: Use globe valves.

### 3.5 JOINT CONSTRUCTION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.
- B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.

### 3.6 SERVICE-ENTRANCE PIPING

- A. Connect fire-suppression piping to water-service piping of size and in location indicated for service entrance to building.

### 3.7 WATER-SUPPLY CONNECTION

- A. Install shutoff valve, pressure gage, drain, and other accessories indicated at connection to water distribution piping.

### 3.8 PIPING INSTALLATION

- A. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices.
- C. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

- D. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
- E. Install sprinkler piping with drains for complete system drainage.
- F. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- G. Install alarm devices in piping systems.
- H. Hangers and Supports: Comply with NFPA 13 for hanger materials.
  - 1. Install sprinkler system piping according to NFPA 13.
- I. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.
- J. Install pressure gages on riser or feed main, and at each sprinkler test connection. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- K. Fill wet-pipe sprinkler system piping with water.

### 3.9 VALVE INSTALLATION

- A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 14 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.

### 3.10 SPRINKLER APPLICATIONS

- A. Where specific types are not indicated, use the following sprinkler types:
  - 1. Rooms without Ceilings: Upright sprinklers. (Quick-Response Sprinklers)
  - 2. Rooms with Suspended Ceilings: Concealed sprinklers. (Quick-Response Sprinklers)
  - 3. Wall Mounting: Sidewall sprinklers. (Quick-Response Sprinklers)
  - 4. Sprinkler Finishes:

- a. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
- b. Flush Sprinklers: Bright chrome, with painted white escutcheon.
- c. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
- d. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

### 3.11 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels and tiles.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

### 3.12 CONNECTIONS

- A. Install piping adjacent to equipment to allow service and maintenance.
- B. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
- C. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
- D. Connect alarm devices to fire alarm.
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.13 LABELING AND IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

### 3.14 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.

3. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
  4. Coordinate with fire alarm tests. Operate as required.
  5. Verify that equipment hose threads are same as local fire department equipment.
- B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

END OF SECTION 211000

## SECTION 220523 - 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. Bronze ball valves.
  - 2. Bronze swing check valves.
  - 3. Bronze globe valves
  - 4. Iron swing check valves.
  - 5. Iron, single-flange butterfly valves.

- B. Related Sections:

- 1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
  - 2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
  - 3. Division 23 Section "Commissioning for HVAC."

#### 1.3 QUALITY ASSURANCE

- A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
- B. NSF Compliance: NSF 61 for valve materials for potable-water service.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to 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.

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- 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 (DN 150) and smaller except plug valves.
- E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
  - 1. 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.
  - 2. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
  - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
  - 2. Solder Joint: With sockets according to ASME B16.18.
  - 3. Threaded: With threads according to ASME B1.20.1.
  - 4. Press: With press end connection rating minimum 200 psig.

## 2.2 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves 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. Red-White Valve Corporation.
    - b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    - c. Milwaukee Valve Company.
    - d. NIBCO INC.
  - 2. Description:
    - a. Standard: MSS SP-110.
    - b. SWP Rating: 150 psig.
    - c. CWP Rating: 600 psig for threaded, soldered, and flanged ends, 200 psig for pressed ends.
    - d. Body Design: Two piece.
    - e. Body Material: Bronze.
    - f. Ends: Threaded, soldered, flanged, or press.
    - g. Seats: PTFE or TFE.
    - h. Stem: Bronze.
    - i. Ball: Chrome-plated brass.
    - j. Port: Full.

## 2.3 BRONZE SWING CHECK VALVES

### A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Red-White Valve Corporation.
  - b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - c. Milwaukee Valve Company.
  - d. NIBCO INC.
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, soldered, flanged, or press.
  - f. Disc: Bronze.

### B. Class 125, Bronze Swing Check Valves with Nonmetallic 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. Red-White Valve Corporation.
  - b. Watts Regulator Co.; a division of Watts Water Technologies, 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, soldered, flanged, or press.
  - f. Disc: PTFE or TFE.

## 2.4 IRON SWING CHECK VALVES

### A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Red-White Valve Corporation.
  - b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
- a. Standard: MSS SP-71, Type I.
  - b. CWP Rating: 200 psig.
  - c. Body Design: Clear or full waterway.
  - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
  - e. Ends: Threaded, soldered, flanged, or press.
  - f. Trim: Bronze.
  - g. Gasket: Asbestos free.

B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:

1. Manufacturers: Subject 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 Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Stockham Division.
2. Description:
- a. Standard: MSS SP-71, Type I.
  - b. CWP Rating: 200 psig.
  - c. Body Design: Clear or full waterway.
  - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
  - e. Ends: Threaded, soldered, flanged, or press.
  - f. Trim: Composition.
  - g. Seat Ring: Bronze.
  - h. Disc Holder: Bronze.
  - i. Disc: PTFE or TFE.
  - j. Gasket: Asbestos free.

## PART 3 - EXECUTION

### 3.1 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.

### 3.2 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.

### 3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
  - 1. Shutoff Service: Ball or butterfly valves.
  - 2. Throttling Service: Ball, globe (hydronic allowed only) or butterfly valves.
  - 3. Pump-Discharge Check Valves:
    - a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
    - b. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below. Press ends are acceptable where approved for piping per 221116-3.12C.
  - 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. Press ends are acceptable where approved for piping per 221116-3.12C.
  - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
  - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
  - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

### 3.4 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
  - 1. Bronze and Brass Valves: May be provided with solder, threaded, or where allowed per spec press ends instead.
  - 2. Ball Valves: Two piece, full port, brass or bronze with brass trim.
  - 3. Bronze Swing Check 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 solder, threaded, or where allowed per spec press ends instead.
2. Iron Swing Check Valves: Class 125, metal seats.
3. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.
4. Iron Gate Valves: Class 125, NRS.

END OF SECTION 220523

## SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Pipe positioning systems.
6. Equipment supports.

#### 1.2 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.
- 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.
1. Design supports for multiple pipes 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.

### PART 2 - PRODUCTS

#### 2.1 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. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

##### B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper- or epoxy-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

## 2.2 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.

## 2.3 METAL FRAMING SYSTEMS

- A. Manufacturer Metal Framing Systems:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.
    - c. Flex-Strut Inc.
    - d. Thomas & Betts Corporation.
    - e. Unistrut Corporation; Tyco International, Ltd.
  2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
  3. Channels: Continuous slotted steel channel with intumed 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.

## 2.4 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa), ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

- E. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

## 2.5 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, zinc-coated 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.

## 2.6 PIPE STANDS

- A. Refer to details on the plans for specific products.
- B. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- C. 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.
- D. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

## 2.7 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

## 2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## 2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

## 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.
- 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. 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 (100 mm) 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 other sections of the specifications for curbs.
- G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) 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. Saddles exposed to view shall have a paint grip surface.
    - b. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) 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 (DN 100) 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 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
    - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
    - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.

- d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
  - e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
- 5. Pipes NPS 8 (DN 200) 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. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.3 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.

### 3.4 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 (40 mm).

### 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.
  - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. 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 and metal trapeze pipe hangers 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- or epoxy-plated pipe hangers and copper 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 (DN 15 to DN 750).
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), 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 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
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 (DN 100 to DN 900), 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 (DN 100 to DN 900), 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 (DN 65 to DN 900) 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 (DN 25 to DN 750), 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 (DN 65 to DN 600), 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 (DN 50 to DN 1050) 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 (DN 50 to DN 600) 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 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

- 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 (DN 24 to DN 600).
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) 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 up to 6 inches (150 mm) for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb (340 kg).
    - b. Medium (MSS Type 32): 1500 lb (680 kg).
    - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
  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. Saddles and shields exposed to view shall have a paint grip surface.
  2. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  3. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  4. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- 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 powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 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.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. 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.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Welding certificates.

C. Field quality-control reports.

#### 1.4 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. 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: D
  - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: IV Occupancy
    - a. Component Importance Factor: 1.5.
    - b. Component Response Modification Factor: Refer to ASCE standard 7-10, Chapter 13.
    - c. Component Amplification Factor: Refer to ASCE standard 7-10, Chapter 13.

#### 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. Kinetics Noise Control, Inc.
    - b. Mason Industries, Inc.
    - c. Vibration Mountings & Controls, 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: Waffle pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.

## 2.3 ELASTOMERIC ISOLATION MOUNTS

### A. Double-Deflection, Elastomeric Isolation Mounts

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Kinetics Noise Control, Inc.
  - b. Mason Industries, Inc.
  - c. Vibration Mountings & Controls, 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. Kinetics Noise Control, Inc.
  - b. Mason Industries, Inc.
  - c. Vibration Mountings & Controls, 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. Kinetics Noise Control, Inc.
  - b. Mason Industries, Inc.
  - c. Vibration Mountings & Controls, 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 (3447 kPa).
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

## 2.6 HOUSED-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Kinetics Noise Control, Inc.
  - b. Mason Industries, Inc.
  - c. Vibration Mountings & Controls, 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 (3447 kPa).
  - b. Top housing with attachment and leveling bolt.

## 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. Kinetics Noise Control, Inc.
  - b. Mason Industries, Inc.
  - c. Vibration Mountings & Controls, 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 (3447 kPa).
  - b. Top plate with threaded mounting holes.
  - 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. Kinetics Noise Control, Inc.
  - b. Mason Industries, Inc.
  - c. Vibration Mountings & Controls, 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 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 (3447 kPa).

- 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- (13-mm-) 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 (3.45 MPa) 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- (13-mm-) 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. Kinetics Noise Control, Inc.
    - b. Mason Industries, Inc.
    - c. Vibration Mountings & Controls, 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. Kinetics Noise Control, Inc.
  - b. Mason Industries, Inc.
  - c. Vibration Mountings & Controls, Inc.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

## 2.13 SNUBBERS

### A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. 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 (6-mm) air gap, and minimum 1/4-inch- (6-mm-) 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. Cooper B-Line, Inc.
  2. Hilti, Inc.
  3. Mason Industries, Inc.
  4. Unistrut.
- 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. Kinetics Noise Control, Inc.
  2. Loos & Co., Inc.
  3. Vibration Mountings & Controls, Inc.
- B. Restraint Cables: ASTM A 603 galvanized 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. Cooper B-Line, Inc.
  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 to hanger rod.
- C. 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.
- D. 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.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- F. 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.

### PART 3 - EXECUTION

#### 3.1 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by 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.

#### 3.2 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.
- 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 (3.2 mm).
  3. Install seismic-restraint devices using methods approved by 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 (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
  3. Brace a change of direction longer than 12 feet (3.7 m).
- 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 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
  5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

### 3.3 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.

### 3.4 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 post connection testing has been approved), and with at least seven days' advance notice.
  - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  - 5. Test to 90 percent of rated proof load of device.
  - 6. Measure isolator restraint clearance.
  - 7. Measure isolator deflection.
  - 8. Verify snubber minimum clearances.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

### 3.5 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 220548

## SECTION 220553 - 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. Valve tags.
  - 5. 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.

#### 1.4 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 EQUIPMENT LABELS

#### A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch, Stainless steel, 0.025-inch 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 self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

#### B. 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.

#### C. 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.

### 2.2 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. General Systems:

1. Letter Color: Red.
2. Background Color: White.
3. Size and Length of Color Field:
  - a. Up to, and including, 1-1/4" outside diameter of pipe or covering: Minimum 8" long color field, 1/2" letter size.
  - b. 1-1/2" to 2" outside diameter of pipe or covering: Minimum 8" long color field, 3/4" letter size.
  - c. 2-1/2" to 6" outside diameter of pipe or covering: Minimum 12" long color field, 1-1/4" letter size.

- d. 8" to 10" outside diameter of pipe or covering: Minimum 24" long color field, 2-1/2" letter size.
- C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- D. Fasteners: Stainless-steel rivets or self-tapping screws.
- E. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- F. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- 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.

## 2.4 VALVE TAGS

- A. 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 minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass S-hook.
- B. Valve Schedules: For each piping system, on 24x36 bond paper, laminated. 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. A copy of the valve-tag schedule shall be included in operation and maintenance data.
  - 2. A copy of valve schedule and valve locations shall be provided in custodial office.

## 2.5 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: Yellow background with black lettering.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### 3.3 PIPE LABEL INSTALLATION

- A. 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 interior and exterior exposed locations as follows:
  - 1. Within 12" of 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, 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.
  - 8. Each leg of a tee.
  - 9. At wall penetrations, both sides of wall.
  - 10. Each riser.

B. Pipe Label Color Schedule:

1. Domestic Water Piping:
  - a. Background Color: Green.
  - b. Letter Color: White.
2. Sanitary Waste, Vent, Condensate, Chemical Waste and Storm Drainage Piping:
  - a. Background Color: White.
  - b. Letter Color: Black.
3. Natural Gas Piping:
  - a. Background Color: Yellow
  - b. Letter Color: Black

C. Special Signs:

1. Room containing Natural Gas Shut-off:
  - a. Sign Location: Visible to anyone working on or near reclaimed water equipment.
  - b. Letter Size 1"
  - c. Letter Color: Black
  - d. Background Color: Yellow
  - e. Wording: GAS SHUT-OFF

3.4 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. Cold Water: 1-1/2 inches round.
    - b. Hot Water: 1-1/2 inches round.
    - c. Natural Gas: 2" square
  2. Valve-Tag Color:
    - a. Cold Water: Natural.
    - b. Hot Water: Natural.

- c. Natural Gas: Yellow.
- 3. Letter Color:
  - a. Cold Water: Black.
  - b. Hot Water: Black.
  - c. Natural Gas: Black.

### 3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where indicated and where required to maintain safe working environment.

### 3.6 VALVES AND EQUIPMENT ABOVE CEILING:

- A. Provide ceiling markers (printed labels) on the ceiling grid nearest the lay-in ceiling tile that should be removed for access to valves and equipment above the ceiling.

END OF SECTION 220553

## SECTION 220719 - 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 cold-water piping.
  - 2. Domestic hot-water piping.
  - 3. Domestic recirculating hot-water piping.
  - 4. Supplies and drains for handicap-accessible lavatories and sinks.
- B. Related Sections:
  - 1. Division 23 Section "HVAC Insulation."

#### 1.3 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).

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

- 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
- B. Materials on site shall be stored inside, protected from weather conditions and shall not be subjected to direct, or indirect, moisture. Any insulation which has been subjected to moisture shall be removed from site and shall not be used.

#### 1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

#### 1.7 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.

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- 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. 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. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed Corp.; SoftTouch Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Friendly Feel Duct Wrap.
    - d. Manson Insulation Inc.; Alley Wrap.
    - e. Owens Corning; SOFTR All-Service Duct Wrap.
- F. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Fibrex Insulations Inc.; Coreplus 1200.
    - b. Johns Manville; Micro-Lok.
    - c. Knauf Insulation; 1000-Degree Pipe Insulation.
    - d. Manson Insulation Inc.; Alley-K.
    - e. Owens Corning; Fiberglas Pipe Insulation.
  - 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. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

## 2.2 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. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aeroflex USA, Inc.; AeroSeal.
    - b. Armacell LLC; Armaflex 520 Adhesive.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
    - d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
    - d. Mon-Eco Industries, Inc.; 22-25.
  2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.
- 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. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
    - d. Mon-Eco Industries, Inc.; 22-25.
  2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following:

- a. Dow Corning Corporation; 739, Dow Silicone.
  - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
  - c. P.I.C. Plastics, Inc.; Welding Adhesive.
  - d. Speedline Corporation; Polyco VP Adhesive.
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

## 2.3 SEALANTS

### A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
  - b. Eagle Bridges - Marathon Industries; 405.
  - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
  - d. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Use sealants that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

### B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
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 (Minus 40 to plus 121 deg C).
5. Color: White.

6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Use sealants that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

## 2.4 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.

## 2.5 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Johns Manville; Zeston.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: White.
  4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    - a. 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.

## 2.6 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  1. Products: Subject to compliance with requirements, provide one of the following:

- a. ABI, Ideal Tape Division; 428 AWF ASJ.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    - c. Compac Corporation; 104 and 105.
    - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  2. Width: 3 inches.
  3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ABI, Ideal Tape Division; 370 White PVC tape.
    - b. Compac Corporation; 130.
    - c. Venture Tape; 1506 CW NS.
  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.

## 2.7 SECUREMENTS

- A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ITW Insulation Systems; Gerrard Strapping and Seals.
    - b. RPR Products, Inc.; Insul-Mate Strapping and Seals.
  2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 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, 1/2 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.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. C & F Wire.
- b. Childers Products.

## 2.8 PROTECTIVE SHIELDING GUARDS

### A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Engineered Brass Company.
  - b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
  - c. McGuire Manufacturing.
  - d. Plumberex.
  - e. Truebro; a brand of IPS Corporation.
  - f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
2. Description: Manufactured plastic piping covers for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
  - a. Material: Rigid, high impact stain resistant PVC, 0.125 in wall thickness.
  - b. Burning Characteristics: ASTM D-635 Self extinguished Self extinguished 0 sec (ATB) mm (AEB).
  - c. Bacteria/Fungus Resistance: 0 growth when tested in accordance with ASTM G21 and G22.

## 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. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  1. Draw jacket tight and smooth.
  2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches 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 (100 mm) 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 (50 mm) 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 (50 mm).
  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 Division 07 Section "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 Division 07 Section "Penetration Firestopping."

### 3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) 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 FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
  1. Install pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
  4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
  1. Install mitered sections of pipe insulation.
  2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
  1. Install preformed valve covers manufactured of same material as pipe insulation when available.
  2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.7 INSTALLATION OF MINERAL-FIBER INSULATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

#### B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), 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 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.

### 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 Division 09 painting Sections.
  - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

### 3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. 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 and fittings, two locations of strainers, and three locations of valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 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.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.12 INDOOR PIPING INSULATION SCHEDULE

#### A. Domestic Cold Water:

1. NPS 1-1/4 and Smaller Insulation shall be:
  - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
2. NPS 1-1/2 and Larger Insulation shall be:
  - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

#### B. Domestic Hot and Recirculated Hot Water (Potable):

1. NPS 1-1/4 and Smaller Insulation shall be:
  - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
2. NPS 1-1/2 and Larger Insulation shall be:
  - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.

#### C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be protective shielding guards.

### 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.
- D. Piping, Exposed, Including Valves:
  1. PVC 20 mils thick, within 96 inches of finished floor and areas subject to abuse.

END OF SECTION 220719

## SECTION 221116 - DOMESTIC WATER 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. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
  - 2. Encasement for piping.

- B. Related Requirements:

- 1. Division 22 Section "Domestic Water Piping Specialties".

#### 1.3 SUBMITTALS

- A. Product Data: For the following products:

- 1. Specialty valves.
  - 2. Transition fittings.
  - 3. Dielectric fittings.
  - 4. Flexible connectors.
  - 5. Water penetration systems.

- B. Water Samples: Specified in "Cleaning" Article.

- C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

- 1. Fire-suppression-water piping.
  - 2. Domestic water piping.
  - 3. HVAC hydronic piping.

#### 1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.

#### 1.5 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

### 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.

#### 2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
  - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
  - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
  - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
  - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint.
  - 5. Grooved-Joint Copper-Tube Appurtenances: Not allowed.
- B. Soft Copper Tube: ASTM B 88, Type L water tube, annealed temper.
  - 1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

#### 2.3 PEX TUBE AND FITTINGS

- A. PEX Distribution System: PEX-a (Engle-Method Crosslinked Polyethylene) Piping: ASTM F 1960
- B. Fittings for PEX-a Tube: elbows, adapters, couplings, plugs, tees and multi-port tees (1/2 inch through 1 inch nominal pipe size): ASTM F1960 cold-expansion fitting manufactured from the following material types:
  - 1. Lead-free (LF) Brass.
  - 2. Reinforcing cold-expansion rings shall be manufactured from the same source as PEX-a piping manufacturer and marked "F1960".

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- C. Multi-Port Tees: Multiple-outlet fitting complying with ASTM F 877; with ASTM F 1960 inlets and outlets.
  - 1. Engineered polymer branch multi-port tee.
  - 2. Engineered polymer flow-through multi-port tee.
  - 3. Engineered polymer commercial branch multi-port tee.
  - 4. Engineered polymer commercial branch multi-port elbow.
  - 5. Engineered polymer commercial flow-through multi-port tee.
- D. Manifolds: Multiple-outlet assembly complying with ASTM F 877; with ASTM F 1960 outlets.
  - 1. Engineered polymer valved manifold.
  - 2. Engineered polymer valveless manifold.
  - 3. Lead - free copper branch manifold.
  - 4. Lead-free copper valved manifold.

## 2.4 TRANSITION FITTINGS

- A. PEX-to-Metal Transition Fittings:
  - 1. Provide fittings from the same manufacturer of the piping.
  - 2. Threaded Brass to PEX-a Transition: one-piece brass fitting with male or female threaded adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
  - 3. Brass Sweat to PEX-a Transition: one-piece brass fitting with sweat adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
- B. PEX-to-Metal Transition Fittings: CPVC or PP-R to PEX-a Transition: one-piece thermoplastic fitting with male or female threaded adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.

## 2.5 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
  - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) 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 A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

## 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. PEX-to-Metal Transition Fittings:

- 1. Provide fittings from the same manufacturer of the piping.
- 2. Threaded Brass to PEX-a Transition: one-piece brass fitting with male or female threaded adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
- 3. Brass Sweat to PEX-a Transition: one-piece brass fitting with sweat adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.

## 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, 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: 150 psig (860 kPa) 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, 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: 150 psig (860 kPa) minimum at 180 deg F.
  - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

2.8 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Flex-Hose Co., Inc.
  - 2. Flexicraft Industries.
  - 3. Flex Pression, Ltd.
  - 4. Flex-Weld, Inc.
  - 5. Hyspan Precision Products, Inc.
  - 6. Mercer Rubber Co.
  - 7. Metraflex, Inc.
  - 8. Proco Products, Inc.
  - 9. Tozen Corporation.
  - 10. Unaflex, Inc.
  - 11. Universal Metal Hose; a Hyspan company
- 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.
  - 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.
2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

### PART 3 - EXECUTION

#### 3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install underground copper tube 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 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. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- K. 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.
- L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

- M. Install piping to permit valve servicing.
- N. 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.
- O. Install piping free of sags and bends.
- P. Install fittings for changes in direction and branch connections.
- Q. Install PEX piping with loop at each change of direction of more than 90 degrees.
- R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in 220500 "Common Work Results For Plumbing."

### 3.2 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," "Brazed 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 recommended by fitting manufacturer.
- G. 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.
- H. Joints for PEX Piping: Join according to ASTM F 1960.

- I. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems. Make joints using minimum of 6" long, brass fittings. Use of dielectric union is not acceptable in domestic water systems, with following exceptions:

- 1. Use 3/4" dielectric copper flex connector for water heater connection

### 3.3 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball for piping NPS 3 and smaller. Use ball or butterfly valve for piping NPS 3 and larger.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
  - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
  - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 3 and smaller, butterfly valves for piping NPS 3 and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.
- E. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.
- F. Install check valves such that they may be disassembled for maintenance without breaking the line.

### 3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
  - 1. NPS 1-1/2 and Smaller: Fitting-type coupling.
  - 2. NPS 2 and Larger: Sleeve-type coupling.

### 3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric unions: not allowed.
- C. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples.
- D. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges or nipples.

### 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.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 inch and below: Maximum span, 32 inches with 3/8-inch rod.
2. Vertical PEX-a Piping: Support PEX-a piping with minimum spacing of 5 feet.
3. Horizontal PEX-a Piping with PEX-a Pipe Channel: Install hangers for PEX-a piping with horizontal support channel in accordance with local jurisdiction and manufacturer's recommendations, with the following maximum spacing:
  4. 3/4 inch and below: Maximum span, 6 feet.
  5. 1 inch and above: Maximum span, 8 feet.
6. PEX-a Riser Supports: Install CTS riser clamps at the base of each floor and at the top of every other floor for domestic hot-water systems. Install mid-story guides between each floor. Install CTS riser clamps at the base of each floor and at the top of every fourth floor for domestic cold-water systems. Install mid-story guides.

### 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:

- 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 (345 kPa) 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.
- D. Do not expose PEX piping to direct sunlight for more than 30 days. If construction delays are encountered, provide cover to portions of piping exposed to direct sunlight.

3.10 ADJUSTING

- A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
  - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
  - b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

### 3.11 CLEANING

#### A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
  - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
  - b. Fill and isolate system according to either of the following:
    - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) 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 (200 mg/L) 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. Dielectric unions may not be used.
- D. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- A. Under-building-slab, domestic water and non-potable water, building service piping, NPS 3 and smaller, shall be the following:
  - 1. Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
- B. Under-building-slab, domestic water and non-potable water, building-service piping, NPS 4 to NPS 8 and larger, shall be the following:
  - 1. Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
- C. Aboveground, exposed domestic water piping, NPS 4 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.
    - a. Mechanical Propress joints are allowed where aboveground pipe is exposed or accessible above demountable ceiling tiles or other means of accessibility is provided.
- D. Aboveground, concealed domestic water piping, NPS 1 and smaller shall be one of the following:

1. PEX-a piping, with engineered polymer (EP) or lead-free brass F1960 cold-expansion fittings, or lead-free brass compression fittings complying with ASTM F 1960.
- E. Aboveground, concealed domestic water piping, NPS 1-1/4 to NPS 6 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,

### 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 for piping NPS 3 and smaller. Use butterfly with flanged ends for piping NPS 3 and larger.
  2. Throttling Duty: Use ball for piping NPS 3 and smaller. Use butterfly with flanged ends for piping NPS 3 and larger.
  3. Hot-Water Circulation Piping, Balancing Duty: Calibrated 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.

END OF SECTION 221116

## SECTION 221119 - 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. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Balancing valves.
3. Temperature-actuated water mixing valves.
4. Strainers.
5. Water hammer arresters.
6. Trap-seal primer valves.
7. Trap-seal primer systems.
8. Hose Bibbs

- B. Related Sections include the following:

1. Division 22 Section "Domestic Water Piping" for water meters.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

## 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Compliance:
  - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
  - 2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

## PART 2 - PRODUCTS

### 2.1 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ames Co.
    - b. Cash Acme.
    - c. Conbraco Industries, Inc.
    - d. FEBCO; SPX Valves & Controls.
    - e. Watts Industries, Inc.; Water Products Div.
    - f. Zurn Plumbing Products Group; Wilkins Div.
  - 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, provide products by one of the following:
    - a. MIFAB, Inc.
    - b. Watts Industries, Inc.; Water Products Div.
    - c. Woodford Manufacturing Company.
    - d. Zurn Plumbing Products Group; Light Commercial Operation.
    - e. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1011.
3. Body: Bronze, non-removable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Rough bronze or Chrome plated.

## 2.2 BALANCING VALVES

### A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Armstrong International, Inc.
  - b. ITT Industries; Bell & Gossett Div.
  - c. Taco, Inc.
2. Type: Ball 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. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

### C. Memory-Stop Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Armstrong International, Inc.
  - b. ITT Industries; Bell & Gossett Div.
  - c. Taco, Inc
  - d. Conbraco Industries, Inc.
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.

## 2.3 TEMPERATURE-ACTUATED WATER MIXING VALVES

### A. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Armstrong International, Inc.
  - b. Lawler Manufacturing Company, Inc.
  - c. Leonard Valve Company.
  - d. Powers; a Watts Industries Co.
2. Standard: ASSE 1017, ASSE 1070 or CSA B125.3.
3. Pressure Rating: 125 psig.
4. Type: Exposed-mounting 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. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
9. Tempered-Water Setting: per Drawings.
10. Tempered-Water Design Flow Rate: per Drawings.
11. Valve Finish: Chrome plated or Polished, chrome plated.
12. Piping Finish: Chrome plated or Copper.

B. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Honeywell Water Controls.
  - b. Lawler Manufacturing Company, Inc.
  - c. Leonard Valve Company.
  - d. Powers; a Watts Industries Co.
  - e. Watts Industries, Inc.; Water Products Div.
  - f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1070, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
4. Check Valves: Integral on hot and cold inlets.
5. Body: Bronze body with corrosion-resistant interior components.
6. Temperature Control: Adjustable.
7. Inlets and Outlet: Threaded.
8. Finish: Rough or chrome-plated bronze.

2.4 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 complying with AWWA C550 or FDA-approved, epoxy coating 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: 0.062 inch.
  - b. Strainers NPS 2-1/2 to NPS 4: 0.062 inch.
6. Drain: Pipe plug.

## 2.5 HOSE BIBBS

### A. Hose Bibb - Interior:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Zurn Plumbing Products Group
  - b. Approved Equal
2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: 125 psig.
8. Vacuum Breaker: Integral anti-siphon 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 or Chrome or nickel plated.
11. Finish for Finished Rooms: Chrome or nickel plated.
12. Operation for Equipment Rooms: Operating key.
13. Operation for Service Areas: 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.

### B. Hose Bibb – Exterior, Nonfreeze:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Josam Company.
  - b. MIFAB, Inc.
  - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - d. Watts Drainage Products.
  - e. Woodford Manufacturing Company; a division of WCM Industries, Inc.

- f. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
  - g. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
- 2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
  - 3. Pressure Rating: 125 psig (860 kPa).
  - 4. Operation: Loose key.
  - 5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
  - 6. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
  - 7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
  - 8. Box: Deep, flush mounted with cover.
  - 9. Box and Cover Finish: Polished nickel bronze
  - 10. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
  - 11. Nozzle and Wall-Plate Finish: Polished nickel bronze
  - 12. Operating Keys(s): Two with each wall hydrant.
- C. Hose Bibb – Exterior, Nonfreeze, Mixing Hot and Cold:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Josam Company.
    - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    - c. Tyler Pipe; Wade Div.
    - d. Watts Drainage Products.
    - e. Woodford Manufacturing Company; a division of WCM Industries, Inc.
    - f. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
  - 2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
  - 3. Pressure Rating: 125 psig (860 kPa).
  - 4. Operation: Loose key.
  - 5. Casing and Operating Rods: Of length required to match wall thickness. Include wall clamps.
  - 6. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
  - 7. Outlet: Concealed.
  - 8. Box: Deep, flush mounted with locking cover.
  - 9. Box and Cover Finish: Polished nickel bronze.
  - 10. Vacuum Breaker:
    - a. Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    - b. Garden-hose thread complying with ASME B1.20.7 on outlet.
  - 11. Operating Keys(s): Two with each wall hydrant.

## 2.6 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.

## 2.7 WATER HAMMER ARRESTERS

### A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AMTROL, Inc.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. PPP Inc.
  - e. Sioux Chief Manufacturing Company, Inc.
  - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - g. Tyler Pipe; Wade Div.
  - h. Watts Drainage Products Inc.
  - i. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

## 2.8 TRAP-SEAL PRIMER DEVICE

### A. Supply-Type, Trap-Seal Primer Device TP-1:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
2. Basis-of-Design Product: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include:
  - a. Precision Plumbing Products, Inc.

3. Standard: ASSE 1018.
4. Pressure Rating: 125 psig (860 kPa) minimum.
5. Body: Bronze.
6. Inlet and Outlet Connections: NPS 1/2 (DN 15) solder joint.
7. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) Solder joint.
8. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

## 2.9 TRAP-SEAL PRIMER SYSTEMS

### A. Trap-Seal Primer Systems, TP-2:

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. Precision Plumbing Products, Inc.
2. Standard: ASSE 1044,
3. Piping: NPS 1/2, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: Recessed-mounting steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: Multiple, of sufficient quantity to service all floor drains in vicinity of drain with 2 spare outlets.
8. Size Outlets: NPS 1/2.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. 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 not acceptable for this application.
  3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

- C. Install solenoid water control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
  - 1. Install thermometers and water regulators if specified.
  - 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve.
- G. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
- H. Install water hammer arresters in water piping according to PDI-WH 201.
- I. Install trap-seal primer systems 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. Provide interconnecting piping between trap primer and floor drain. Piping may not be shown.
- J. Install seismic joints in accordance with manufacturer's recommendations.
- K. Install vacuum breakers outside of walls or in recessed cabinets. Overflow from vacuum breakers located inside the building must flow directly to a drain.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
  - 1. Test each reduced-pressure-principle backflow preventer and double-check backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.4 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

## SECTION 221123 – 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 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes fuel gas piping below grade and within the building. Products include the following:
  - 1. Pipe, tube, fittings, and joining materials.
  - 2. Piping specialties.
  - 3. Specialty valves.
  - 4. Pressure regulators.
  - 5. Solenoid valves.
  - 6. Earthquake valves.
  - 7. Meter for EMCS monitoring
  - 8. Seismic joints.
  - 9. Pipe stands.
- B. Related Sections
  - 1. Division 23 Section “Commissioning of HVAC.”

#### 1.3 PROJECT CONDITIONS

- A. Gas System Pressures: Natural gas pressure within the building is 2 psi and is reduced to secondary pressure of at the equipment.

#### 1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Pressure regulators. Include pressure rating, capacity, and settings of selected models.
  - 2. Buried pipe.
- B. Operation and Maintenance Data: For natural gas specialties and accessories to include in emergency, operation, and maintenance manuals.

## 1.5 QUALITY ASSURANCE

- A. NFPA Standard: Comply with NFPA 54, "National Fuel Gas Code."
- B. System installer shall be familiar with cathodic protection design and installation.

## 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 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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

### 2.3 PIPES, TUBES, FITTINGS, AND JOINING MATERIALS

- A. Steel Pipe: ASTM A 53/A 53M; Type S; Grade B; black. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.
  - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
  - 2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
  - 3. Joint Compound and Tape: Suitable for natural gas.
  - 4. Steel Flanges and Flanged Fittings: ASME B16.5.
  - 5. Gasket Material: Thickness, material, and type suitable for natural gas.
- B. PE Pipe: ASTM D 2513, SDR 11.
  - 1. PE Fittings: ASTM D 2683, socket type or ASTM D 3261, butt type with dimensions matching ASTM D 2513, SDR 11, PE pipe.
- C. Transition Fittings: Manufactured pipe fitting with one PE pipe end for heat-fusion connection to PE pipe and with one ASTM A 53/A 53M, Schedule 40, steel pipe end for threaded connection to steel pipe.

- D. Service-Line Risers at Building: Manufactured PE pipe fitting with PE pipe inlet for heat-fusion connection to underground PE pipe; PE pipe riser section with protective-coated, anodeless, steel casing and threaded outlet for threaded connection to aboveground steel piping.

## 2.4 PIPING SPECIALTIES

- A. Flexible Connectors: Not allowed.

## 2.5 SPECIALTY VALVES

- A. Valves, NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
- B. Valves, NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
- C. Appliance Connector Valves: ANSI Z21.15 and CSA International listed.
- D. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.
- E. Gas Valves, NPS 2 and Smaller: ASME B16.33 and CSA International-listed bronze body and 125-psig pressure rating.
- F. General-Duty Valves, NPS 2-1/ and Larger: ASME B16.38, cast-iron body, suitable for fuel gas service, with "WOG" indicated on valve body, and 125-psig pressure rating.
  - 1. Gate Valves: MSS SP-70, OS&Y type with solid wedge.
  - 2. Butterfly Valves: MSS SP-67, lug type with lever handle.
- G. Solenoid Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Asco Red Hat
    - b. Approved equal
  - 2. Approvals:
    - a. UL: 429 Electrically Operated Valves.
    - b. FM: Process control valves.
  - 3. Body: Brass
  - 4. Seals and disc: NBR.
  - 5. Core Tube: 305 Stainless Steel.

6. Electrical:
  - a. Voltage: 120 VAC
  - b. Power Consumption:
    - 1) 25 VA holding.
    - 2) 70 VA inrush.
7. Position: Normally closed (power to open).

## 2.6 PRESSURE REGULATORS

- A. Description: Single stage and suitable for fuel gas service. Include steel jacket and corrosion-resistant components, elevation compensator, and atmospheric vent.
  1. Available Manufacturers:
    - a. Line Pressure Regulators:
      - 1) American Meter Company.
      - 2) Fisher Controls International, Inc.; Division of Emerson.
      - 3) Invensys.
      - 4) Maxitrol Company.
      - 5) National Meter Industries, Inc.
      - 6) Schlumberger Limited; Gas Div.
  2. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
  3. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
  4. Line Pressure Regulators: ANSI Z21.80 with 2-psig-minimum.
- B. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening.

## 2.7 EARTHQUAKE VALVES

- A. Earthquake Valves: Comply with ASCE 25.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Pacific Seismic Products, Inc.
  2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  3. Maximum Operating Pressure: 60 psig.
  4. Cast-aluminum body with stainless-steel internal parts.

5. Nitrile-rubber, reset-stem o-ring seal.
6. Valve position, open or closed, indicator.
7. Composition valve seat with clapper held by spring or magnet locking mechanism.
8. Level indicator.
9. End Connections: Threaded for valves NPS 2 and smaller; flanged for valves NPS 2-1/2 and larger.

## 2.8 METERS FOR EMCS MONITORING

### A. Turbine Meters: Comply with ASME MFC-4M.

1. Manufacturers: Subject 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. Housing: Cast iron or welded steel.
3. Connection Threads or Flanges: Steel.
4. Turbine: Aluminum or plastic.
5. Turbine Bearings: Self-lubricating.
6. Compensation: Continuous temperature.
7. Meter Index: Cubic feet.
8. Tamper resistant.
9. Remote volume pulser: Normally open, Form A contact switch for interface with EMCS..
10. Maximum Inlet Pressure: 100 psig.
11. Accuracy: Maximum plus or minus 2.0 percent.

## 2.9 SEISMIC JOINTS

- 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. Metraflex
- B. Seismic Rating: Required. Joint shall be listed specifically for use with natural gas.
- C. Construction: Two flexible sections of hose and braid, two 45° elbows and a 90° return. Factory supplied center support, drain/air release plug.
- D. Minimum movement: 6" +/- in X, Y and Z planes.

## 2.10 PIPE STANDS

- 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. Miro Industries, Inc.
- B. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
- C. Base: Plastic.
- D. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
- E. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Flanges, unions, transition, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, unless otherwise indicated.
- B. Fuel Gas Piping, 2 psig or Less:
  - 1. Through 2": Black Steel pipe with threaded or welded fittings. No threaded gas pipes greater than 2 psi inside of building.
  - 2. 2-1/2" diameter and greater: Steel pipe, welded or flanged fittings.
- C. Underground Fuel Gas Piping: PE pipe, PE fittings, and heat-fusion joints. Provide cathodically protected tracer wire.
- D. Underground-to-Aboveground Piping Connections: Service-line riser.
- E. PE-to-Steel Piping Connections: Transition fitting.

### 3.2 VALVE APPLICATIONS

- A. Appliance Shutoff Valves for Pressure 0.5 psig or Less: Appliance connector valve or gas stop.
- B. Piping Line Valves, NPS 2 and Smaller: Gas valve.
- C. Piping Line Valves, NPS 2-1/2 and Larger: Plug valve or general-duty valve.

- D. Install earthquake valve aboveground outside buildings according to listing, downstream of meter.
- E. Install solenoid valve at indicated locations and connect to power.
- F. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping gas mains.
  - 1. Underground: Use PE valves.
  - 2. Aboveground, NPS 2 and Smaller: Lubricated tapered plug valves.

### 3.3 PIPING INSTALLATION

- A. Install underground, natural gas distribution piping buried at least 24 inches below finished grade.
- B. Install underground, PE, natural gas distribution piping according to ASTM D 2774.
- C. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.
  - 1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.
  - 2. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls.
    - a. Exception: Tubing passing through partitions or walls.
  - 3. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    - a. Exception: Accessible above-ceiling space specified above.
- D. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.
- E. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- F. Connect branch piping from top or side of horizontal piping.
- G. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

- H. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.
- I. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.
- J. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying.
- K. Seismic joints: Install per manufacturer's recommendations and in accordance with listing requirements.

### 3.4 JOINT CONSTRUCTION

- A. Use materials suitable for fuel gas.

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support and equipment support materials and installation requirements are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. 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.
- C. Pipe Stand Installation:
  - 1. Pipe Stand: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

### 3.6 CONNECTIONS

- A. Connect gas distribution piping to natural gas source and extend to points indicated. Connect to building's natural gas piping if it is installed; otherwise, terminate piping with caps, plugs, or flanges, as required for piping material.
- B. Drawings indicate general arrangement of fuel gas piping, fittings, and specialties.
- C. Install piping adjacent to appliances to allow service and maintenance.
- D. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.

- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

### 3.7 FIELD QUALITY CONTROL

- A. Test, inspect, and purge piping according to NFPA 54, WAC 480-93 and CFR 49 Part 192 and requirements of authorities having jurisdiction.
- B. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.
- C. Verify capacities and pressure ratings of service meters, pressure regulators, valves, and specialties.
- D. Verify correct pressure settings for pressure regulators.
- E. Verify that specified piping tests are complete.

### 3.8 METER FOR EMCS INSTALLATION

- A. Install meter assemblies as indicated.
- B. Install strainer on inlet of meter set.
- C. Install metal shutoff valves upstream from meters. Install dielectric fittings downstream from meters.
- D. Coordinate meter remote data output requirements with Division 23 "Instrumentation and Control for HVAC." Connect to EMCS.

END OF SECTION 221123

## SECTION 221316 - 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. Pipe, tube, and fittings.
  - 2. Specialty pipe fittings.

#### 1.3 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.
- 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.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. 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.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 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.

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.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301
- B. Heavy-Duty, Hubless-Piping Couplings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ANACO-Husky.
    - b. Clamp-All Corp.
    - c. MIFAB, Inc.
    - d. Tyler Pipe.
  - 2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
  - 3. Certifications and Standards
    - a. ASTM C 1540.
    - b. FM 1680 Class 1
    - c. CSA B 602
    - d. IAPMO File 6726

2.3 ABS PIPE AND FITTINGS

- A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
- B. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

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C. Solvent Cement: ASTM D 2235.

1. ABS solvent cement shall have a VOC content of 325 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Solvent cement 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."

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Shielded, Non-pressure Transition Couplings:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Cascade Waterworks Mfg. Co.
    - 2) Mission Rubber Company; a division of MCP Industries, Inc.
  - 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.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Capitol Manufacturing Company.
    - 2) Central Plastics Company.
    - 3) Hart Industries International, Inc.
    - 4) Jomar International Ltd.
    - 5) Matco-Norca, Inc.
    - 6) McDonald, A. Y. Mfg. Co.
    - 7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.

- 8) Wilkins; a Zurn company.
- 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.
3. Dielectric Flanges:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Capitol Manufacturing Company.
    - 2) Central Plastics Company.
    - 3) Matco-Norca, Inc.
    - 4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    - 5) Wilkins; a Zurn company.
  - 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.
4. Dielectric-Flange Insulating Kits:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of 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.

### PART 3 - EXECUTION

#### 3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling per Geotechnical Report.

#### 3.2 PIPING INSTALLATION

- A. 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.
- 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 Division 22 Section "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. 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. 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. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

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- L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- M. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
  - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
  - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
  - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
  - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- O. Plumbing Specialties:
  - 1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."
  - 2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
- P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

### 3.3 JOINT CONSTRUCTION

- A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- B. 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.

### 3.4 SPECIALTY PIPE FITTING INSTALLATION

#### A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Unshielded or Shielded, nonpressure transition couplings.

#### B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or flange kits or nipples.

### 3.5 HANGER AND SUPPORT INSTALLATION

#### A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

#### B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. 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.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.

#### C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

#### D. Support vertical piping and tubing at base and at each floor.

#### E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

#### F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.

4. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
  1. NPS 2: 10 feet with 3/8-inch rod.
- I. Install supports for vertical steel piping every 15 feet.
- J. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
  1. NPS 2: 96 inches with 3/8-inch rod.
- K. Install supports for vertical copper tubing every 10 feet.
- L. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
  1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
  2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
  3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
  4. NPS 6 and NPS 8 (DN 150 and DN 200): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
- M. Install supports for vertical PVC piping every 48 inches (1200 mm).
- N. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

### 3.6 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 drainage and vent piping to the following:
  1. Plumbing Fixtures: Connect drainage 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 drainage 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. Comply with requirements for cleanouts and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
  6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. 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.

### 3.7 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

### 3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage 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. 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 drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. 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. 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. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. 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.

### 3.9 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

### 3.10 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. All, except waste stacks between floors: Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
  2. Waste stacks between floors: Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
  3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
  1. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.

- D. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
1. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
  2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 221316

## SECTION 221319 - 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. This Section includes the following sanitary drainage piping specialties:
  - 1. Cleanouts.
  - 2. Floor drains.
  - 3. Floor Sinks
  - 4. Vent Caps.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

#### 1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

### PART 2 - PRODUCTS

#### 2.1 CLEANOUTS

- A. Exposed Cast-Iron Cleanouts:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Josam Company; Josam Div.
    - b. MIFAB, Inc.
    - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    - d. Tyler Pipe; Wade Div.

- e. Watts Drainage Products Inc.
  - f. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
  - 3. Size: Same as connected drainage piping
  - 4. Body Material: Hub-less, cast-iron soil pipe test tee as required to match connected piping.
  - 5. Closure: Countersunk plug.
  - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Floor Cleanouts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Josam Company; Josam Div.
  - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - c. Tyler Pipe; Wade Div.
  - d. Watts Drainage Products Inc.
  - e. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.36.2M for cast-iron soil pipe with cast-iron ferrule cleanout.
- 3. Size: Same as connected branch.
- 4. Type: Cast-iron soil pipe with cast-iron ferrule.
- 5. Body or Ferrule: Cast iron.
- 6. Clamping Device: Not required.
- 7. Outlet Connection: Inside calk.
- 8. Closure: Brass plug with straight threads and gasket.
- 9. Adjustable Housing Material: Cast iron with threads.
- 10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
- 11. Frame and Cover Shape: Round.
- 12. Top Loading Classification: Heavy Duty.
- 13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

- 1. Subject to compliance with requirements, provide product by one of the following:
  - a. Josam Company; Josam Div.
  - b. MIFAB, Inc.
  - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - d. Tyler Pipe; Wade Div.
  - e. Watts Drainage Products Inc.
  - f. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.36.2M. Include wall access.
- 3. Size: Same as connected drainage piping.
- 4. Body: Hub-less, cast-iron soil pipe test tee as required to match connected piping.

5. Closure: Countersunk, drilled-and-threaded plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
8. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

## 2.2 FLOOR DRAINS

### A. Cast-Iron Floor Drains:

1. Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Josam Company; Josam Div.
  - b. MIFAB, Inc.
  - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - d. Watts Drainage Products Inc.
  - e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3.
3. Pattern: Floor and Funnel floor (see drawings).
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Clamping Device: Required.
7. Outlet: Bottom.
8. Backwater Valve: Not required.
9. Coating on Interior and Exposed Exterior Surfaces: Not required.
10. Sediment Bucket: Not required.
11. Top or Strainer Material: Bronze.
12. Top Shape: Square tiled areas, round in all others.
13. Sheet Flooring Clamping Strainer Flange: Required in areas with sheet flooring.
14. Top Loading Classification: Heavy duty.
15. Funnel: Required on certain locations, see drawings.

## 2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

### A. 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.

### B. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.

2. Design: To provide 1-inch (25-mm) enclosed air space between outside of pipe and inside of flashing collar extension, with counter-flashing.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. 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.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. 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. Set with grates depressed according to the following drainage area radii:
    - a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
    - b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
    - c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.
  3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
  4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- E. 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.

- F. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- G. Install vent caps on each vent pipe passing through roof.
- H. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.
- I. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

### 3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each grease interceptor.
- 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 Division 22 Section "Identification for Plumbing Piping and Equipment."

### 3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.
- C. Per School District Facilities Standards-Vandal resistant is required in seclusion room floor drain and fasteners

END OF SECTION 221319

## SECTION 224000 - 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.
- B. Related Sections include the following:
  - 1. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
  - 2. Division 22 Section "Pressure Water Coolers."

#### 1.2 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
  - 1. Faucets for lavatories, showers, whirlpools, instant hot water taps, and sinks.
  - 2. Ice maker boxes
  - 3. Flushometers.
  - 4. Toilet seats.
  - 5. Protective shielding guards.
  - 6. Fixture supports.
  - 7. Water closets.
  - 8. Urinals
  - 9. Lavatories.
  - 10. Commercial sinks
  - 11. Service basins
  - 12. Service sinks

#### 1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
- D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

- E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- F. FRP: Fiberglass-reinforced plastic.
- G. PMMA: Polymethyl methacrylate (acrylic) plastic.
- H. PVC: Polyvinyl chloride plastic.
- I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- D. Warranty: Special warranty specified in this Section.

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
  - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
  - 1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
  - 2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
  - 3. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
  - 4. Stainless-Steel Commercial, Hand Wash Sinks: NSF 2 construction.
  - 5. Stainless-Steel Residential Sinks: ASME A112.19.3.
  - 6. Vitreous-China Fixtures: ASME A112.19.2M.
  - 7. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
  - 8. Water-Closet, Flushometer Tank Trim: ASSE 1037.
- H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
  - 1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
  - 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
  - 3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
  - 4. Faucets: ASME A112.18.1.
  - 5. Hose-Connection Vacuum Breakers: ASSE 1011.
  - 6. Hose-Coupling Threads: ASME B1.20.7.
  - 7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
  - 8. NSF Potable-Water Materials: NSF 61.
  - 9. Pipe Threads: ASME B1.20.1.
  - 10. Supply Fittings: ASME A112.18.1.
  - 11. Brass Waste Fittings: ASME A112.18.2.
- I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
  - 1. Atmospheric Vacuum Breakers: ASSE 1001.
  - 2. Brass and Copper Supplies: ASME A112.18.1.
  - 3. Dishwasher Air-Gap Fittings: ASSE 1021.
  - 4. Manual-Operation Flushometers: ASSE 1037.
  - 5. Plastic Tubular Fittings: ASTM F 409.
  - 6. Brass Waste Fittings: ASME A112.18.2.
  - 7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

- J. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
2. Dishwasher Air-Gap Fittings: ASSE 1021.
3. Flexible Water Connectors: ASME A112.18.6.
4. Floor Drains: ASME A112.6.3.
5. Hose-Coupling Threads: ASME B1.20.7.
6. Off-Floor Fixture Supports: ASME A112.6.1M.
7. Pipe Threads: ASME B1.20.1.
8. Plastic Shower Receptors: ANSI Z124.2.
9. Plastic Toilet Seats: ANSI Z124.5.
10. Supply and Drain Protective Shielding Guards: ICC A117.1.

#### 1.6 WARRANTY

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
  - a. Structural failures of unit shell.
  - b. Faulty operation of controls, blowers, pumps, heaters, and timers.
  - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period for Commercial Applications: Three year from date of Substantial Completion.

#### 1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed, but no less than one of each.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed, but no less than one of each.
3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.
4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
5. Toilet Seats: Equal to 5 percent of amount of each type installed.

## PART 2 - PRODUCTS

### 2.1 LAVATORY FAUCETS

#### A. Lavatory Faucets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide a product by the manufacturer(s) listed below:
  - a. Chicago Faucets
  - b. No exceptions
2. Description: Dual handle metering faucet.
  - a. Standard: ADA Compliant; NSF/ANSI 372 Low Lead Content
  - b. Body Material: Commercial, solid brass.
  - c. Finish: Polished chrome plate.
  - d. Maximum Flow: 0.5 gpm
  - e. Centers: 4"
  - f. Mounting: Deck, concealed.
  - g. Valve Handle(s): Double, round metering.
  - h. Inlet(s): (2) NPS 1/2 male shank.
  - i. Spout: Integral.
  - j. Spout Outlet: Non-Aerating, pressure compensating, vandal resistant.
  - k. Operation: Self-closing, auto-timed metering cartridge
  - l. California Health & Safety Code Compliance: Required
  - m. Drain: Grid.
  - n. Mixing Valve: Watts LFMMV, ASSE 1070 compliant, integral hot and cold check valves.

### 2.2 SINK FAUCETS

#### A. Sink Faucets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide a product by the manufacturer(s) listed below:
  - a. Chicago Faucets
  - b. No exceptions
2. Description: Classroom Sink. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
  - a. Standard: ADA ANSI/ICC A117.1
  - b. Body Material: Commercial, solid brass.
  - c. Finish: Polished chrome plate.

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- d. Maximum Flow Rate: 2.2 gpm, unless otherwise indicated.
- e. Centers: Single hole
- f. Mounting: Deck, concealed.
- g. Handle(s): Lever
- h. Inlet(s): NPS 1/2 male shank.
- i. Spout Type: Rigid/swing gooseneck.
- j. Spout Outlet: Pressure compensating Softflow aerator.
- k. Extra Spout Outlet: 0.5 gpm aerator, shipped loose.
- l. Bubbler: Chicago 748-665ABCP, push-button valve bubbler, built-in adjustable water volume control.
- m. Drain: Crumb cup.

## 2.3 FLUSHOMETERS

### A. Flushometers:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide a product by the manufacturer(s) listed below:
  - a. Sloan Valve Company
  - b. No exceptions
- 2. Standard: ASSE 1037.
- 3. Minimum Pressure Rating: 125 psig (860 kPa).
- 4. Features: Include integral check stop and backflow-prevention device.
- 5. Material: Brass body with corrosion-resistant components.
- 6. Exposed Flushometer-Valve Finish: Chrome plated.
- 7. Style: Exposed
- 8. Internal Design: Diaphragm operation
- 9. Consumption: 1.28 gal. per flush.
- 10. Inlet Size: NPS 1 (DN 25).
- 11. Trip Mechanism: Oscillating, lever-handle actuator
- 12. Bumper Stop: Required.

## 2.4 TOILET SEATS

### A. Toilet Seats:

- 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. American Standard Companies, Inc.
  - b. Bemis
  - c. Kohler Co.

2. Description: Toilet seat for water-closet-type fixture.
  - a. Material: Molded, solid plastic with antimicrobial agent.
  - b. Configuration: Open front without cover.
  - c. Size: Elongated.
  - d. Hinge Type: CK, check.
  - e. Class: Standard commercial.
  - f. Color: White

## 2.5 PROTECTIVE SHIELDING GUARDS

### A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Engineered Brass Co.
  - b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
  - c. McGuire Manufacturing Co., Inc.
  - d. Plumberex Specialty Products Inc.
  - e. TCI Products.
  - f. TRUEBRO, Inc.
  - g. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.
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.

## 2.6 FIXTURE SUPPORTS

### A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Josam Company.
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

### B. Water-Closet Supports:

1. Standard: ASME A112.6.1M.

2. 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. Heavy duty wall carrier shall be used for student toilet room. Optional M40 support (by Jay R. Smith or equal) shall be provided for additional rigidity.

C. Urinal Supports:

1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

D. Lavatory Supports:

1. ASME A112.6.1M, Type III, lavatory carrier. Include rectangular, steel uprights. Floor mounted.

E. Sink Supports:

1. ASME A112.6.1M, Type II, sink carrier.

## 2.7 WATER CLOSETS

A. Water Closets:

1. 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. American Standard Companies, Inc.
  - b. Kohler Co.
2. Description: Wall mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
  - a. Standard: ADA ANSI/ICC A117.1
  - b. Style: One piece.
    - 1) Bowl Type: Elongated with siphon-jet design.
    - 2) Design Consumption: 1.28 gal/flush
    - 3) Color: White.
  - c. Flush Valve: Required.
  - d. Supply: NPS 1-1/2" chrome-plated brass or copper with wheel-handle stop.
  - e. Fixture Support: As indicated.

## 2.8 LAVATORIES

### A. Lavatories, L-2:

1. 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. American Standard Companies, Inc.
  - b. Kohler Co.
  - c. Sloan
2. Description: Accessible, wall-mounting, vitreous china fixture.
  - a. Standard: ADA ANSI/ICC A117.1
  - b. Type: Ledge back
  - c. Size: 18"x21" rectangular.
  - d. Faucet Hole Punching: Three holes, spacing to match faucet.
  - e. Faucet Hole Location: Top.
  - f. Color: White.
  - g. Faucet: Required.
  - h. Supplies: NPS 3/8 chrome-plated copper with stops.
  - i. Drain: Grid.
  - j. Drain Piping: NPS 1-1/4 by NPS 1-1/2 chrome-plated, cast-brass P-trap with cleanout plug; NPS 1-1/2 (DN40) thick tubular brass waste to wall; and wall escutcheon.

## 2.9 COMMERCIAL SINKS

### A. Commercial Sinks:

1. 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. Elkay Manufacturing Co.
2. Description: One-compartment, counter-mounting, stainless-steel commercial, classroom.
  - a. Overall Dimensions: 25"x17".
  - b. Compartment:
    - 1) Dimensions: 16"x13-1/2"x6-1/2".
    - 2) Drain: NPS 1-1/2 tailpiece with grid strainer.
      - a) Location: Centered in rear of compartment.

- c. Faucet(s): Required.
  - 1) Number Required: One.
  - 2) Mounting: Side ledge.
- d. bubbler: Required.
  - 1) Mounting: Side ledge, opposite faucet.
- e. Construction: Seamless die-drawn, 18 gauge type 304 stainless steel. Self-rimming top with stainless steel mounting channels. Self-rimming top with stainless steel mounting channels. Fully coated underside for sound deadening and condensation reduction.
- f. Supplies: NPS 1/2 chrome-plated copper with loose key angle stops.
- g. Drain Piping: NPS 2 chrome-plated, cast-brass P-trap with cleanout plug; 0.045-inch-thick tubular brass waste to wall; and wall escutcheon(s).
- h. Standard: ADA ANSI/ICC A117.1

### 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 plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
  - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
  - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
  - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install wall-mounting fixtures with tubular waste piping attached to supports.
- E. Install fixtures level and plumb according to roughing-in drawings.

### PLUMBING FIXTURES

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- F. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
  - 1. Exception: Use ball valve if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- G. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- H. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- I. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- J. Install toilet seats on water closets.
- K. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- L. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- M. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- N. Install traps on fixture outlets.
  - 1. Exception: Omit trap on fixtures with integral traps.
  - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- O. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

### 3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

### 3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust disposers controls. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.

### 3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
  - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
  - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

### 3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.
- C. Per School District Facilities Standards-Vandal resistant is required on all fixtures, materials and fasteners.

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END OF SECTION 224000

PLUMBING FIXTURES

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## SECTION 224716 - PRESSURE WATER COOLERS

### 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 pressure water coolers and related components.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of pressure water cooler.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

#### 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filter Cartridges: Equal to three of each.

### PART 2 - PRODUCTS

#### 2.1 PRESSURE WATER COOLERS

- A. Pressure Water Coolers Recessed.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Elkay Manufacturing Co.
  - b. Halsey Taylor.
  - c. Haws Corporation.
2. Standards:
  - a. Comply with NSF 61.
  - b. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
3. Cabinet: Bi-level with two attached cabinets, 14 Ga stainless steel.
4. Bubbler: One, with adjustable stream regulator, located on each cabinet deck
5. Control: Push button.
6. Vandal resistant, heavy duty, lead-free.
7. Drain: Grid with NPS 1-1/4 (DN 32) tailpiece.
8. Supply: NPS 3/8 (DN 10) with shutoff valve.
9. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 (DN 32) brass P-trap.
10. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
11. Cooling System: Electric, hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
  - 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.
12. Capacities and Characteristics:
  - a. Cooled Water: 8 gph (0.0084 L/s).
  - b. Ambient-Air Temperature: 90 deg F (32 deg C).
  - c. Inlet-Water Temperature: 80 deg F (27 deg C.)
  - d. Cooled-Water Temperature: 50 deg F (10 deg C).
  - e. Electrical Characteristics: See Schedule.
13. Ventilation Grille: Stainless steel, located below water cooler.
14. Support: Mounting frame for attaching to substrate.
15. Accessories: Bottle filling station.

### 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. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.
- C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation.
- D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings.
- F. 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. Install valve upstream from filter for water cooler.
- D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

### PRESSURE WATER COOLERS

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3.4 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

3.5 CLEANING

- A. After installing fixture, 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 224716

## SECTION 230500 - COMMON WORK RESULTS 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.

#### 1.2 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.

#### 1.3 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.
- F. Provide: Furnish and install.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

### PART 2 - PRODUCTS

#### 2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

#### 2.2 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
- C. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

#### 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).

### COMMON WORK RESULTS FOR HVAC

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## 2.4 SLEEVES

- A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

## 2.5 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.

## 2.6 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire-stop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- O. Verify final equipment locations for roughing-in.
- P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### 3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 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.

### 3.3 PIPING CONNECTIONS

- A. 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. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### 3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC 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.

### 3.5 GROUTING

- A. Mix and install grout for HVAC 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.

3.6 COMMISSIONING

- A. The equipment and systems referenced in this section are to be commissioned per Section 019113 – General Commissioning Requirements and Section 230800 – Commissioning of HVAC Systems. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 230500

## SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC 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.
- B. Related Sections:
  - 1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
  - 2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Brass ball valves.
  - 2. Bronze ball valves.
  - 3. Bronze swing check valves.
  - 4. Iron swing check valves.

#### 1.3 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: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve schedule articles for applications of valves.

## GENERAL-DUTY VALVES FOR HVAC PIPING

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- 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. Hand-Wheel: For valves other than quarter-turn types.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
  - 1. 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.
- F. Valve-End Connections:
  - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
  - 2. Solder Joint: With sockets according to ASME B16.18.
  - 3. Threaded: With threads according to ASME B1.20.1.

## 2.2 BRONZE BALL VALVES

- A. One-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Red and White Valve Company.
  - 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 or TFE.
    - g. Stem: Bronze.
    - h. Ball: Chrome-plated brass.
    - i. Port: Reduced.
- B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Red-White Valve Corporation.

2. Description:

- a. Standard: MSS SP-110.
  - b. SWP Rating: 150 psig.
  - c. CWP Rating: 600 psig.
  - d. Body Design: Two piece.
  - e. Body Material: Bronze.
  - f. Ends: Threaded.
  - g. Seats: PTFE or TFE.
  - h. Stem: Bronze.
  - i. Ball: Chrome-plated brass.
  - j. Port: Full.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Red and White Valve Company.

2. Description:

- a. Standard: MSS SP-110.
  - b. SWP Rating: 150 psig.
  - c. CWP Rating: 600 psig.
  - d. Body Design: Two piece.
  - e. Body Material: Bronze.
  - f. Ends: Threaded.
  - g. Seats: PTFE or TFE.
  - h. Stem: Bronze.
  - i. Ball: Chrome-plated brass.
  - j. Port: Regular.

2.3 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Red-White Valve Corporation.
2. Description:
- a. Standard: MSS SP-71, 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 Design: Clear or full waterway.
  - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
  - f. Ends: Flanged.
  - g. Trim: Bronze.
  - h. Gasket: Asbestos free.

### 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 swing check valves for proper direction of flow and in horizontal position with hinge pin level.

### 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 valve applications are not indicated, use the following:
  - 1. Shutoff Service: Ball valves.
  - 2. Throttling Service: ball valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-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.

### 3.5 HEATING-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
  - 1. Bronze and Brass Valves: May be provided with solder-joint ends or threaded ends.
  - 2. Ball Valves: One piece, regular port, bronze with brass trim.
  - 3. Bronze Swing Check 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 or flanged ends.

END OF SECTION 230523

## SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC 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. This Section includes the following:
  - 1. Steel pipe hangers and supports.
  - 2. Thermal-hanger shield inserts.
  - 3. Fastener systems.
  - 4. Equipment supports.
- B. See Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
- C. See Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

#### 1.3 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

#### 1.5 SUBMITTALS

- A. Product Data: For the following:

### HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

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1. Steel pipe hangers and supports.
  2. Thermal-hanger shield inserts.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
1. Equipment supports including attachments to structure.

## 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 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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Available Manufacturers:
1. AAA Technology & Specialties Co., Inc.
  2. Bergen-Power Pipe Supports.
  3. Carpenter & Paterson, Inc.
  4. Globe Pipe Hanger Products, Inc.
  5. Grinnell Corp.
  6. National Pipe Hanger Corporation.
  7. PHS Industries, Inc.
  8. Piping Technology & Products, Inc.
  9. Tolco Inc.
- C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

## 2.3 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Available Manufacturers:
  - 1. Carpenter & Paterson, Inc.
  - 2. ERICO/Michigan Hanger Co.
  - 3. PHS Industries, Inc.
  - 4. Pipe Shields, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

## 2.4 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1. Available Manufacturers:
    - a. B-Line Systems, Inc.; a division of Cooper Industries.
    - b. Empire Industries, Inc.
    - c. Hilti, Inc.
    - d. ITW Ramset/Red Head.
    - e. MKT Fastening, LLC.
    - f. Powers Fasteners.

## 2.5 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

## 2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Non-staining, noncorrosive, and nongaseous.
  2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

### PART 3 - EXECUTION

#### 3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified 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 padded hangers for piping that is subject to scratching.
- F. 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 120 to 450 deg F pipes, NPS 4 to NPS 16, 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 24, requiring clamp flexibility and up to 4 inches of insulation.
  4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
  5. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
  6. 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.
  7. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
  8. 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.
- G. 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 20.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. 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.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. 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.
  8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- J. 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.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).

2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
  3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- B. Fastener System Installation:
1. Install powder-actuated fasteners 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.
- C. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- D. Double nut required on all threaded hangers.
- E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- F. 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.
- G. Install lateral bracing with pipe hangers and supports to prevent swaying.
- H. 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.
- I. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

- J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- K. Insulated Piping: Comply with the following:
  - 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 according to ASME B31.1 for power piping and 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.
  - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - 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 inserts.
  - 6. Insert Material: Length at least as long as protective shield.
  - 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

### 3.5 PAINTING

- A. Touch Up: 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. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

### 3.7 COMMISSIONING

- A. Commissioning Authority
  - 1. The commissioning authority (CA) has been contracted directly with the owner for this project. The CA has overall responsibility for planning and coordinating the commissioning process. However commissioning involves all parties involved with the design and construction process, including the mechanical (Division 22 & 23) contractor, and all specialty sub-contractors within Division 23, such as sheet metal, piping, refrigeration, water treatment, TAB and controls, plus major equipment suppliers as required.

END OF SECTION 230529

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
1. Isolation pads.
  2. Freestanding and restrained spring isolators.
  3. Spring hangers.
  4. Restraining braces and cables.
  5. Restrained isolation roof-curb rails

1.2 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
1. Basic Wind Speed: See S0.1.
  2. Building Classification Category: See S0.1.
- B. Seismic-Restraint Loading:
1. Site Class as Defined in the IBC: See S0.1.
  2. Assigned Seismic Use Group or Building Category as Defined in the IBC: See S0.1.
    - a. Component Importance Factor: 1.0.
    - b. Component Response Modification Factor: Refer to ASCE standard 7-10, Chapter 13.
    - c. Component Amplification Factor: Refer to ASCE standard 7-10, Chapter 13.

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 agency acceptable to authorities having jurisdiction.
    - b. Annotate to indicate application of each product submitted and compliance with requirements.
  3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
  2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
1. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases 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, operation, and seismic and wind forces required to select vibration isolators and seismic and wind restraints and for designing vibration isolation bases.
    - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
  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- and Wind-Restraint Details:
    - a. Design Analysis: To support selection and arrangement of seismic and wind 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 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 HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

## PART 2 - PRODUCTS

### 2.1 VIBRATION ISOLATORS

- 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. Ace Mountings Co., Inc.
  2. California Dynamics Corporation.
  3. Isolation Technology, Inc.
  4. Kinetics Noise Control.
  5. Mason Industries.
  6. Vibration Mountings & Controls, Inc.
- B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene.
- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
  6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
  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.
- E. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. 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.
  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. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

## 2.2 SEISMIC-RESTRAINT DEVICES

- A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
1. 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 will be subjected.
- B. Channel Support System: MFMA-3, shop- or field-fabricated support 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; and rated in tension, compression, and torsion forces.
- C. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- E. 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.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

- G. 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. Minimum length of eight times diameter.

## 2.3 RESTRAINED ISOLATION ROOF-CURB RAILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Kinetics Noise Control.
  - 2. Mason Industries, Inc.
  - 3. Thybar Corporation.
- B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.
- C. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces.
- D. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches (50 mm) of rigid, glass-fiber insulation on inside of assembly. Adjustable, 2" deflection restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
- E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch (6 mm) thick.
- F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counter-flashed over roof materials.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

- B. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

### 3.2 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Equipment Restraints:
  - 1. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- C. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127.
  - 2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
  - 3. Brace a change of direction longer than 12 feet (3.7 m).
- D. Install cables so they do not bend across edges of adjacent equipment or building structure.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- F. 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.
- G. 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 pre-stressed 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 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.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 230548

## SECTION 230553 - IDENTIFICATION FOR HVAC 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. Pipe labels.
  - 3. Duct labels.
  - 4. Valve tags.

#### 1.3 SUBMITTAL

- A. Product Data: For each type of product indicated.

### PART 2 - PRODUCTS

#### 2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
  - 1. Material and Thickness: Brass, 0.032-inch, Stainless steel, 0.025-inch 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 self-tapping screws.
  - 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- B. 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.
- C. 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.

## 2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pre-Tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- 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.

## 2.3 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- D. 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.
- E. Fasteners: Stainless-steel rivets or self-tapping screws.
- F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches high.
- H. 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 minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass S-hook.
- I. Valve Schedules: For each piping system, on 24x36 bond paper, framed with glazed cover. 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.
- J. A copy of the valve-tag schedule shall be included in operation and maintenance data

### 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 EQUIPMENT LABEL INSTALLATION

- A. All air and piping systems shown on plans shall be labeled.
- B. Install or permanently fasten labels on each major item of mechanical equipment.
- C. Locate equipment labels where accessible and visible.
- D. Provide P-touch labels on ceiling tiles to indicate location of equipment above ceiling-such as VAV boxes, shut-off valves for heating, air and plumbing piping, and all other equipment that are accessed for maintenance.

#### 3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "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. 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.
- C. Pipe Label Color Schedule:
1. Heating Water Piping:
    - a. Background Color: White.
    - b. Letter Color: Black.

### 3.4 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
1. Blue: For cold-air supply ducts.
  2. Yellow: For hot-air supply ducts.
  3. Green: For exhaust, return.
- B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

### 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. All valves in the building shall be tagged and identified.
- 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. Heating Hot Water: 1-1/2 inches round.
2. Valve-Tag Color:
  - a. Heating Hot Water: Natural.
3. Letter Color:
  - a. Heating Hot Water: Red.

END OF SECTION 230553

## SECTION 230593 - TESTING, ADJUSTING, AND BALANCING 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.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Balancing Air Systems:
    - a. Variable-air-volume systems.
  - 2. Balancing Hydronic Piping Systems:
    - a. Constant-flow hydronic systems.
    - b. Variable-flow hydronic systems.
  - 3. Balancing Domestic Piping Systems:
    - a. Constant-flow domestic hot water circulation systems.

#### 1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

#### 1.4 SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. Certified TAB reports.
- E. Sample report forms.
- F. 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.

#### 1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
  - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.
  - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.
- B. TAB Conference: Meet with Architect on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
  - 1. Agenda Items:
    - a. The Contract Documents examination report.
    - b. The TAB plan.
    - c. Coordination and cooperation of trades and subcontractors.
    - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
  - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
  - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Architect.

- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

## 1.6 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

## 1.7 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

## PART 2 - PRODUCTS (NOT USED)

## 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. All air and hydronic systems shall be tested, adjusted and balanced.
- C. Examine systems for installed 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 accessible.
- D. Examine the approved submittals for HVAC systems and equipment.
- E. 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.
- F. Examine ceiling plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 233113 "Metal Ducts" and are properly

## TESTING, ADJUSTING, AND BALANCING FOR HVAC

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separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

- G. 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.
- H. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- I. Examine test reports specified in individual system and equipment Sections.
- J. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- K. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- L. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- M. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- O. Examine system pumps to ensure absence of entrained air in the suction piping.
- P. Examine operating safety interlocks and controls on HVAC equipment.
- Q. 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 strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing," and in this Section.
  1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- 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, patch probe holes in ducts with same material and thickness as used to construct ducts.
  2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
  3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC 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. Crosscheck 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 Division 23 Section "Metal Ducts."

### 3.5 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
  - 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
  - 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure 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.
  - 3. Measure total system airflow. Adjust to within indicated airflow.
  - 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
  - 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

- a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
6. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
  - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record final fan-performance data.

### 3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
  1. Open all manual valves for maximum flow.
  2. Check liquid level in expansion tank.
  3. Check makeup water-station pressure gage for adequate pressure for highest vent.
  4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
  5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
  6. Set system controls so automatic valves are wide open to heat exchangers.
  7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
  8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

### 3.7 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. Efficiency rating.
  5. Nameplate and measured voltage, each phase.

6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

### 3.8 TOLERANCES

- A. Set HVAC system's air flow 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 5 percent.
  3. Heating-Water Flow Rate: Plus or minus 10 percent.
- B. Set domestic hot water recirculation system water flow rates to maintain measurable water flow through each branch.

### 3.9 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 weekly 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. Include significant testing notes and comments where airflows and water flows or other recorded data outputs are not within the AABC, NEBB and/or spec standard tolerances from design numbers. Describe issues such that they can communicate whether the design, installation, access testing conditions, or other factors can be identified to the project team for response.

### 3.10 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.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
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.
  - d. Summarized of testing notes and comments where airflows, water flows, or recorded outputs are not within AABC, NEBB and/or spec standard tolerances from design numbers.
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 (mm), and bore.
  - i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
  - j. Number, make, and size of belts.
  - k. Number, type, and size of filters.
2. Motor Data:
  - a. Motor make, and frame type and size.
  - b. Horsepower and rpm.
  - c. Volts, phase, and hertz.
  - d. Full-load amperage and service factor.
  - e. Sheave make, size in inches (mm), and bore.
  - f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
3. Test Data (Indicated and Actual Values):
  - a. Total air flow rate in cfm (L/s).
  - b. Total system static pressure in inches wg (Pa).
  - c. Fan rpm.
  - d. Discharge static pressure in inches wg (Pa).
  - e. Filter static-pressure differential in inches wg (Pa).
  - f. Preheat-coil static-pressure differential in inches wg (Pa).
  - g. Cooling-coil static-pressure differential in inches wg (Pa).
  - h. Heating-coil static-pressure differential in inches wg (Pa).
  - i. Outdoor airflow in cfm (L/s).
  - j. Return airflow in cfm (L/s).
  - k. Outdoor-air damper position.
  - l. Return-air damper position.
  - m. Vortex damper position.

- F. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup
- G. 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 (deg C).
    - d. Duct static pressure in inches wg (Pa).
    - e. Duct size in inches (mm).
    - f. Duct area in sq. ft. (sq. m).
    - g. Indicated air flow rate in cfm (L/s).
    - h. Indicated velocity in fpm (m/s).
    - i. Actual air flow rate in cfm (L/s).
    - j. Actual average velocity in fpm (m/s).
    - k. Barometric pressure in psig (Pa).
- H. 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. (sq. m).
  2. Test Data (Indicated and Actual Values):
    - a. Air flow rate in cfm (L/s).
    - b. Air velocity in fpm (m/s).
    - c. Preliminary air flow rate as needed in cfm (L/s).
    - d. Preliminary velocity as needed in fpm (m/s).
    - e. Final air flow rate in cfm (L/s).
    - f. Final velocity in fpm (m/s).
    - g. Space temperature in deg F (deg C).
- I. 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. Air flow rate in cfm (L/s).
  - b. Entering-water temperature in deg F (deg C).
  - c. Leaving-water temperature in deg F (deg C).
  - d. Water pressure drop in feet of head or psig (kPa).
  - e. Entering-air temperature in deg F (deg C).
  - f. Leaving-air temperature in deg F (deg C).

J. Instrument Calibration Reports:

1. Report Data:
- a. Instrument type and make.
  - b. Serial number.
  - c. Application.
  - d. Dates of use.
  - e. Dates of calibration.

3.11 INSPECTIONS

A. Initial Inspection:

- 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
- 2. Check the following for each system:
  - a. Measure airflow of at least 20 percent of air outlets.
  - b. Measure water flow of at least 10 percent of terminals.
  - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
  - d. Verify that balancing devices are marked with final balance position.
  - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

- 1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
- 2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect.

3. Architect and 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.
  4. 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."
  5. 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.
- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
1. 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 contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
- D. Prepare test and inspection reports.

### 3.12 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 230593

## SECTION 230700 - HVAC 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.
- B. Related Sections:
  - 1. Division 22 Section "Plumbing Insulation."

#### 1.2 SUMMARY

- A. Section Includes the following duct systems:
  - 1. Indoor, concealed supply and outdoor air.
  - 2. Indoor, exposed outdoor air.
  - 3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
  - 4. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
  - 5. Outdoor, exposed supply and return.
  - 6. Outdoor, concealed supply and return.
- B. Section Includes the following HVAC equipment that is not factory insulated:
  - 1. Heat exchangers.
  - 2. Converters.
  - 3. Heating, hot-water pumps.
  - 4. Expansion/compression tanks.
  - 5. Air separators.
- C. Section Includes the following HVAC piping systems:
  - 1. Condensate drain piping, indoors.
  - 2. Heating hot-water piping, indoors.

#### 1.3 REFERENCES

- A. Oregon Energy Efficiency Specialty Code – Latest Edition and as amended by local Authority Having Jurisdiction.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.

#### 1.5 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

#### 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 Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

#### 1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- D. 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. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cell-U-Foam Corporation; Ultra-CUF.
    - b. Pittsburgh Corning Corporation; Foamglass Super K.
    - c. Or approved equal
  - 2. Block Insulation: ASTM C 552, Type I.
  - 3. Special-Shaped Insulation: ASTM C 552, Type III.
- E. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
  - 1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Aeroflex USA Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. K-Flex USA
    - d. Or approved equal.
- F. Flexible Elastomeric With Integral Covering Membrane: Closed-cell material. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
  - 1. Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Aeroflex USA Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. K-Flex USA

2. Covering Membrane

- a. Construction: Blended polymeric top surface, puncture resistant base, scrim reinforced core.
- b. Thickness: 12 mil minimum.
- c. Color: White.

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 III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. CertainTeed Corp.; Duct Wrap.
  - b. Johns Manville; Microlite.
  - c. Knauf Insulation; Duct Wrap.
  - d. Manson Insulation Inc.; Alley Wrap.
  - e. Owens Corning; All-Service Duct Wrap.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Fibrex Insulations Inc.; Coreplus 1200.
  - b. Johns Manville; Micro-Lok.
  - c. Knauf Insulation; 1000 Pipe Insulation.
  - d. Manson Insulation Inc.; Alley-K.
  - e. Owens Corning; Fiberglas Pipe Insulation.
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. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

- a. CertainTeed Corp.; CrimpWrap.
- b. Johns Manville; MicroFlex.
- c. Knauf Insulation; Pipe and Tank Insulation.
- d. Manson Insulation Inc.; AK Flex.
- e. Owens Corning; Fiberglas Pipe and Tank Insulation.

## 2.2 FIRE RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed Corp.; FlameChek.
    - b. Johns Manville; Firetemp Wrap.
    - c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.
    - d. Thermal Ceramics; FireMaster Duct Wrap.
    - e. 3M; Fire Barrier Wrap Products.
    - f. Unifrax Corporation; FyreWrap.

## 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, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).
  1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-96.
    - b. Foster Products Corporation, H. B. Fuller Company; 81-33.
    - c. Or approved equal
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Aeroflex USA, Inc.; Aeroseal.
    - b. Armacell LLC; Armaflex 520 Adhesive.

- c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
    - d. K-Flex USA; R-373 Contact Adhesive.
  - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.
    - e. Mon-Eco Industries, Inc.; 22-25.
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
    - d. Mon-Eco Industries, Inc.; 22-25.
  - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.
- F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Dow Chemical Company (The); 739, Dow Silicone.
  - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
  - c. P.I.C. Plastics, Inc.; Welding Adhesive.
  - d. Red Devil, Inc.; Celulon Ultra Clear.
  - e. Speedline Corporation; Speedline Vinyl Adhesive.

## 2.4 SEALANTS

### A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Childers Products, Division of ITW; CP-76-8.
  - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
  - c. Marathon Industries, Inc.; 405.
  - d. Mon-Eco Industries, Inc.; 44-05.
  - e. Vimasco Corporation; 750.
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.

### B. ASJ Flashing Sealants, and Vinyl, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Childers Products, Division of ITW; CP-76.
  - b. Or approved equal
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.

## 2.5 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
  2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
  3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
  4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
  5. PVDC Jacket for Indoor Applications: 4-mil thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
    - a. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
      - 2) Or approved equal.
  6. PVDC Jacket for Outdoor Applications: 6-mil thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
    - a. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
      - 2) Or approved equal.
  7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
    - a. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2) Or approved equal.

8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

## 2.6 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. 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. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Johns Manville; Zeston.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto PVC Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: Color-code jackets based on system. Color as selected by Architect.
  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.
  5. Factory-fabricated tank heads and tank side panels.
- D. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.
  1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; Metal Jacketing Systems.
    - b. PABCO Metals Corporation; Surefit.
    - c. RPR Products, Inc.; Insul-Mate.
  2. Sheet and roll stock ready for shop or field sizing.
  3. Finish and thickness are indicated in field-applied jacket schedules.

4. Moisture Barrier for Indoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.
  5. Moisture Barrier for Outdoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.
  6. Factory-Fabricated Fitting Covers:
    - a. Same material, finish, and thickness as jacket.
    - b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - c. Tee covers.
    - d. Flange and union covers.
    - e. End caps.
    - f. Beveled collars.
    - g. Valve covers.
    - h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. Self-Adhesive Outdoor Jacket: 60-mil thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Polyguard; Alumaguard 60.
    - b. Or approved equal.
- F. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
    - b. Or approved equal.

## 2.7 TAPES

- A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    - b. Compac Corp.; 110 and 111.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
    - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
  2. Width: 3 inches.
  3. Thickness: 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
    - b. Compac Corp.; 130.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
    - d. Venture Tape; 1506 CW NS.
  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.
- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - b. Compac Corp.; 120.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
    - d. Venture Tape; 3520 CW.
  2. Width: 2 inches (50 mm).
  3. Thickness: 3.7 mils (0.093 mm).
  4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
  5. Elongation: 5 percent.
  6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

## 2.8 SECUREMENTS

### A. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
  - a. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
    - 2) GEMCO; Perforated Base.
    - 3) Midwest Fasteners, Inc.; Spindle.
  - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
  - a. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) GEMCO; Nylon Hangers.
    - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
  - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
  - c. Spindle: Nylon, 0.106-inch diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

- a. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
    - 2) GEMCO; Press and Peel.
    - 3) Midwest Fasteners, Inc.; Self Stick.
  - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive-backed base with a peel-off protective cover.
4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- a. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) AGM Industries, Inc.; RC-150.
    - 2) GEMCO; R-150.
    - 3) Midwest Fasteners, Inc.; WA-150.
    - 4) Nelson Stud Welding; Speed Clips.
  - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- a. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) GEMCO.
    - 2) Midwest Fasteners, Inc.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, galvanized steel.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. C & F Wire.
- b. Childers Products.
- c. PABCO Metals Corporation.
- d. RPR Products, Inc.

## 2.9 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that applies to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties. Insulation of piping, ductwork and equipment shall at a minimum meet Oregon Energy Efficiency Specialty Code requirements.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.

- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. 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 o.c.
  - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. 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.
- O. 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. Manholes.
  - 5. Handholes.
  - 6. Cleanouts.

### 3.3 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 Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
  - 1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.
- D. Insulation Installation at Floor Penetrations:
  - 1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
  - 2. Pipe: Install insulation continuously through floor penetrations.
  - 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

### 3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
  - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
  - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular

- surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic.
  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, vessels, and equipment. 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 (50 mm) 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.

### 3.5 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
  1. Install pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
  4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
  1. Install mitered sections of pipe insulation.
  2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
  1. Install preformed valve covers manufactured of same material as pipe insulation when available.
  2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  3. Install insulation to flanges as specified for flange insulation application.
  4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION WITH INTEGRAL COVERING MEMBRANE

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. All work shall conform to manufacturer's requirements.
- C. Install exterior sheet insulation with positive slope.

3.7 MINERAL-FIBER INSULATION INSTALLATION

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 but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

- 1. Install preformed pipe insulation to outer diameter of pipe flange.
- 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
- 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
- 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), 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.
- E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
  2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not overcompress insulation during installation.
    - e. Impale insulation over pins and attach speed washers.
    - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
  5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

### 3.8 FIELD-APPLIED JACKET INSTALLATION

A. 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 (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. 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.

### 3.9 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

### 3.10 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.

- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

### 3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Inspect ductwork, 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 one location for each duct system defined in the "Duct Insulation Schedule, General" Article.
  - 2. Inspect field-insulated equipment, 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 one location for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
  - 3. 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.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.12 DUCT INSULATION SCHEDULE, GENERAL

- A. See below for duct insulation requirements:
  - 1. Indoor, concealed supply and outdoor air.
  - 2. Indoor, exposed outdoor air.
  - 3. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
  - 4. Indoor, concealed oven and warewash exhaust.
  - 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
  - 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
  - 7. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Factory-insulated flexible ducts.
2. Flexible connectors.
3. Vibration-control devices.
4. Factory-insulated access panels and doors.

3.13 DUCT AND PLENUM INSULATION SCHEDULE

DUCT TYPE	DUCT LOCATION	INSULATION R VALUE	INSULATION TYPE	OTHER REQUIREMENTS
Supply, Return, Exhaust	Not within conditioned space: In attic, in enclosed ceiling space, in walls.	R-7	Flexible Elastomeric with Integral Covering Membrane	Approved weather proof barrier.
Supply, Return	Within Conditioned Space: Concealed and Exposed Within Equipment Rooms	R-7	Mineral fiber blanket or rigid fiber board.	
Outside Air Intake	Exposed outdoors.	R-8	Mineral fiber blanket or rigid fiber board.	R-21 between intake and motorized damper.

3.14 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
  2. Underground piping.
  3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.15 PIPING INSULATION SCHEDULE

#### A. Indoor:

1. Heating-Hot-Water Supply and Return, NPS 1.25" and less, 105-140 Deg F: Mineral-Fiber, Preformed Pipe, Type I, 1 inch thick.
2. Heating-Hot-Water Supply and Return, NPS 1.5" and larger, 105-140 Deg F: Mineral-Fiber, Preformed Pipe, Type I, 1-1/2" inch thick

### 3.16 FIELD-APPLIED JACKET SCHEDULE

#### A. Indoor:

1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
2. If more than one material is listed, selection from materials listed is Contractor's option.
3. Piping, exposed in Mechanical Room and elsewhere where exposed, up to 8'-0" A.F.F.: PVC: 30 mils thick.
4. Equipment, exposed, Aluminum, 0.024inches thick.

#### B. Outdoor

1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
2. Ducts up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches: Galvanized steel, 20 gauge.
3. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches: Galvanized steel, 18 gauge.
4. Piping, Exposed: Aluminum: 0.020 inches thick.

END OF SECTION 230700

## SECTION 230800 - COMMISSIONING OF HVAC SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. The purpose of this section is to specify the Division 23 responsibilities and participation in the commissioning process. See Division 1, Section 019113, "General Commissioning Requirements," for Contractor-related commissioning requirements.
  - 1. Organization of the commissioning program is primarily the responsibility of the Commissioning Provider. Execution of the program is primarily the responsibility of the Contractor with support from the Division 23 contractor for:
    - a. Testing and start-up of the mechanical equipment.
    - b. Completion and endorsement of prefunctional test checklists provided by the Commissioning Provider to assure that Division 23 equipment and systems are fully operational and ready for functional testing.
    - c. Providing qualified personnel to conduct the functional test steps under the direction and supervision of the Commissioning Provider to verify equipment/system performance under all modes of operation.
    - d. Providing equipment, materials, and labor necessary to conduct all necessary test steps and correct deficiencies found during the commissioning process which fulfill contract and warranty requirements.
    - e. Providing hands-on training to the Districts Maintenance Staff on the operation and maintenance of the systems specified in Division 23 with coordination of Owner and the Commissioning Provider.
- B. Division 23 Contractor shall cooperate with the Commissioning Provider in the following manner:
  - 1. Allow sufficient time before final completion dates so that test and balance, controls point-to-point checkout, and functional testing can be accomplished without impact to the final delivery date of the project.
  - 2. Provide labor and material to make corrections when required without undue delay.
  - 3. Put all heating, ventilating, and air conditioning systems and equipment into full operation, and continue the operation of the same during each working day of commissioning.

C. Related Sections

1. Section 019113 – General Commissioning Requirements.
2. Division 26 – Electrical.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Standard certified test equipment required for conducting the functional performance testing during the commissioning process will be provided by the Contractors.
- B. Proprietary test equipment required by the manufacturer shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist the Commissioning Provider in the commissioning process as necessary and at no cost.

PART 3 - EXECUTION

3.1 WORK PRIOR TO COMMISSIONING

- A. Specific pre-commissioning responsibilities of Division 23 are as follows:
  1. Normal start-up services required to bring each system into a fully operational state. This includes motor rotational check, cleaning, filling, purging, control sequences of operation, leak testing, full-load and part-load performance, etc. per manufacturers factory authorized start-up documentation and procedures.
  2. Normal testing, adjusting and balancing services required to verify each system is operating at design capacities, by a certified TAB firm.
  3. Execute functional tests and complete prefunctional test checklists for the following equipment and systems:
    - a. Heating water system
    - b. Air handling units
    - c. Terminal units
    - d. Automated control systems
    - e. Emergency power systems
    - f. Exhaust Fans
    - g. Ceiling Fans
- B. Factory start-up services for key equipment and systems specified in Division 23. The Division 23 Contractor shall coordinate this work with the manufacturer and the Commissioning Provider.

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### 3.2 PARTICIPATION IN COMMISSIONING

- A. The Division 26 Contractor shall provide skilled technicians to start-up and debug all systems within the Division 23 work (particularly with controls equipment). These same technicians shall be made available to assist the Commissioning Provider in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc., will be requested by the Commissioning Provider and coordinated by the Contractor. Contractor will ensure the qualified technician(s) are available and present during the agreed upon schedules, and of sufficient duration to complete the necessary tests, adjustments and/or problem resolutions.
- B. The Commissioning Provider reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment, system, and/or sub-system. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment, and an attitude/willingness to work with the Commissioning Provider to get the job done. A liaison or intermediary between the Commissioning Provider and qualified factory representatives does not constitute the availability of a qualified technician for purposes of this work.

### 3.3 WORK TO RESOLVE DEFICIENCIES

- A. Maladjustments, misapplied equipment, and/or deficient performance under varying loads will result in a system that does not meet Acceptable Performance. Correction of work will be completed under the direction of the Architect, with input from the Contractor, Equipment Supplier, and Commissioning Provider. Whereas all members will have input and the opportunity to discuss, debate, and work out problems, the Architect/Engineer-of-Record will have final jurisdiction on the necessary work to be done to achieve performance and/or design intent. Owner will have final approval of acceptance of work product.

### 3.4 SEASONAL COMMISSIONING AND OCCUPANCY VARIATIONS

- A. Seasonal commissioning pertains to testing under full-load conditions during peak heating and peak cooling seasons, as well as part-load conditions in the spring and fall. Initial commissioning will be done as soon as contract work is completed regardless of season. All equipment and systems will be tested and commissioned in a peak season to observe full-load performance. Example: Heating equipment will be tested during winter design extremes. The Contractor will be responsible to participate in the initial and the alternate peak season test of the systems required demonstrating performance.
- B. Subsequent commissioning may be required under conditions of minimum and/or maximum occupancy or use. All equipment and systems affected by occupancy variations will be tested and commissioned at the minimum and peak loads to observe system performance. The Contractor will be responsible to participate in the occupancy sensitive testing of systems to provide verification of adequate performance.

### 3.5 TRAINING

- A. The Division 23 Contractor will be required to participate in the training of the Owner's engineering and maintenance staff for each mechanical system and the related components. Training will be conducted in a classroom setting, with system and component documentation, and suitable classroom training aids, and in the field with the specific equipment. Contractor shall submit a formal Training Plan to the Commissioning Provider for approval, 3 months prior to start of Training Period. Training Plan shall include, at a minimum:

1. Title of Training Subject
2. Name and qualifications of trainer
3. Classroom Agenda
4. Field Agenda
5. Method of verification of training success

END OF SECTION 230800

## SECTION 230900 - INSTRUMENTATION AND CONTROL 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.

#### 1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units. All electrical wiring, raceways, breakers, transformers, final connections, and other miscellaneous equipment necessary to provide power to the Controls shall be provided as part of the Control system unless explicitly indicated in work of other Divisions. Convenience outlets and convenience outlet circuits shall not be used as a source of power.
- B. Architecture: Resident BACnet.
- C. The intent of this project is to connect to the existing building management system that is already present on site. New equipment added or relocated as part of this TI will be connected to the existing system for monitoring and control to match what is already present elsewhere on site.
- D. Related Sections include the following:
  - 1. Division 22 Section "Domestic Water Piping Specialties" for measuring equipment that relates to this Section.
  - 2. Division 22 Section "Facility Natural Gas Piping" for measuring equipment that relates to this Section
  - 3. Division 23 Section "Air Terminal Units" for requirements that relate to this Section
  - 4. Division 23 Section "Variable Frequency Motor Controllers" for requirements that relate to this Section.
  - 5. Division 23 Section "Packaged, Outdoor, Central-Station Air-Handling Units" for measuring equipment that relates to this Section.

#### 1.3 DEFINITIONS

- A. DDC: Direct digital control.
- B. I/O: Input/output.

- C. MS/TP: Master slave/token passing.
- D. PC: Personal computer.
- E. PID: Proportional plus integral plus derivative.
- F. RTD: Resistance temperature detector.

#### 1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
  - a. Water Temperature: Plus or minus 1 deg F).
  - b. Water Flow: Plus or minus 5 percent of full scale.
  - c. Water Pressure: Plus or minus 2 percent of full scale.
  - d. Space Temperature: Plus or minus 1 deg F.
  - e. Ducted Air Temperature: Plus or minus 1 deg F.
  - f. Outside Air Temperature: Plus or minus 2 deg F.
  - g. Temperature Differential: Plus or minus 0.25 deg F.
  - h. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
  - i. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
  - j. Airflow (Terminal): Plus or minus 10 percent of full scale.
  - k. Air Pressure (Space): Plus or minus 0.01-inch wg.
  - l. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
  - m. Carbon Dioxide: Plus or minus 50 ppm.

#### 1.5 SEQUENCE OF OPERATION

- A. As indicated on plan.

## 1.6 SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
  2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
  3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
  2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
  3. Wiring Diagrams: Power, signal, and control wiring.
  4. Details of control panel faces, including controls, instruments, and labeling.
  5. Written description of sequence of operation.
  6. Schedule of dampers including size, leakage, and flow characteristics.
  7. Schedule of valves including flow characteristics.
  8. DDC System Hardware:
    - a. Wiring diagrams for control units with termination numbers.
    - b. Schematic diagrams and floor plans for field sensors and control hardware.
    - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
  9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
  10. Controlled Systems:
    - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    - c. Written description of sequence of operation including schematic diagram.
    - d. Points list.

- C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- D. Software and Firmware Operational Documentation: Include the following:
  - 1. Software operating and upgrade manuals.
  - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
  - 3. Device address list.
  - 4. Printout of software application and graphic screens.
  - 5. Software license required by and installed for DDC workstations and control systems.
- E. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- F. Qualification Data: For Installer and manufacturer. The Controls contractor shall be regularly engaged in the engineering, programming, installation, and service of Control systems by the selected manufacturer and shall have a minimum of five years' experience with the complete, turn-key installation of Controls by the same manufacturer of similar size and technical complexity. If portions of the installation will be performed by a subcontractor, the Controls Contractor will submit to the owner two sample installations performed by subcontractor which are similar to the current project. The controls contractors shall have local branch facility within a 75-mile radius of the job site. Emergency Service shall be available on a 24-hour, 7-day a week basis.
- G. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
  - 2. Interconnection wiring diagrams with identified and numbered system components and devices.
  - 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
  - 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
  - 5. Calibration records and list of set points.

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project. Selection of Controls Contractor is subject to approval by owner.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer. In the event equipment manufacturer cannot, or will not, factory mount controls, controls shall be field mounted.
- B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

- A. Coordinate location of thermostats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Division 26 Section "Lighting Control Devices" to achieve compatibility with equipment that interfaces with that system.
- C. Coordinate equipment with Division 28 Section "Digital, Addressable Fire Alarm System" to achieve compatibility with equipment that interfaces with that system.
- D. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Replacement Materials: One replacement diaphragm or relay mechanism for each unique valve motor controller thermostat positioning relay.
  - 2. Maintenance Materials: Two thermostat adjusting keys.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of control system that fail in materials or workmanship with specified warranty period.
  - 1. Warranty Period: For Carbon Dioxide (CO2) Sensors: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, furnish products and systems installed by only authorized Johnson Controls contractors.
- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- C. Control system shall be fully functional without interface to Owner's front end.
- D. Control system shall be fully accessible via Internet from a remote workstation, without the use of additional hardware.

### 2.2 DDC EQUIPMENT

- A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
  - 1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
  - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    - a. Global communications.
    - b. Discrete/digital, analog, and pulse I/O.
    - c. Monitoring, controlling, or addressing data points.
    - d. Software applications, scheduling, and alarm processing.
    - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:
    - a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
    - b. HVAC Control Programs: Optimal run time, supply-air reset.
    - c. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
    - d. Remote communications.
    - e. Maintenance management.
    - f. Units of Measure: Inch-pound.
  4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
  5. Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
  6. The control unit shall have a 10% extra capacity for expansion to meet future operational needs.
- B. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
  2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    - a. Global communications.
    - b. Discrete/digital, analog, and pulse I/O.
    - c. Monitoring, controlling, or addressing data points.
  3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
  4. Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
  5. The control unit shall have a 10% extra capacity for expansion to meet future operational needs.
- C. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
1. Binary Inputs: Allow monitoring of on-off signals without external power.
  2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
  3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.

4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
  5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
  6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
  7. Universal I/Os: Provide software selectable binary or analog outputs.
- D. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
1. Output ripple of 5.0 mV maximum peak to peak.
  2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
  3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- E. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations and controllers with the following:
1. Minimum dielectric strength of 1000 V.
  2. Maximum response time of 10 nanoseconds.
  3. Minimum transverse-mode noise attenuation of 65 dB.
  4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

## 2.3 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
  2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
  3. Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
  4. Enclosure: Waterproof rated for operation at 40 to 150 deg F.

## 2.4 ANALOG CONTROLLERS

- A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.
- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
  - 1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
- D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.
- E. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
  - 1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.
  - 2. Proportional band shall extend from 2 to 20 percent for 5 psig.
  - 3. Authority shall be 20 to 200 percent.
  - 4. Air-supply pressure of 18 psig, input signal of 3 to 15 psig, and output signal of zero to supply pressure.
  - 5. Gages: 2-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

## 2.5 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
  - 1. Accuracy: Plus or minus 0.36 deg F at calibration point.
  - 2. Wire: Twisted, shielded-pair cable.
  - 3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
  - 4. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.

5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
  - a. Set-Point Adjustment: Concealed.
  - b. Set-Point Indication: Exposed.
  - c. Thermometer: Exposed.
  - d. Color: Black.
  - e. Orientation: Vertical.
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. RTDs and Transmitters:

1. Accuracy: Plus or minus 0.2 percent at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
4. Averaging Elements in Ducts: 18 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
  - a. Set-Point Adjustment: Concealed.
  - b. Set-Point Indication: Exposed.
  - c. Thermometer: Concealed.
  - d. Color: Black.
  - e. Orientation: Vertical.
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

D. Pressure Transmitters/Transducers:

1. Available Manufacturers:
  - a. Veris PW
  - b. BEC Controls Corporation.
  - c. General Eastern Instruments.
  - d. MAMAC Systems, Inc.
  - e. ROTRONIC Instrument Corp.
  - f. TCS/Basys Controls.
  - g. Vaisala.

2. Static-Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.
    - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
    - b. Output: 4 to 20 mA.
    - c. Building Static-Pressure Range: 0- to 0.25-inch wg.
    - d. Duct Static-Pressure Range: 0- to 5-inch wg.
  3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
  4. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.
- E. Carbon Dioxide (CO2) Sensors:
1. Wall mounted or duct mounted as indicated, with suitable range for expected range.
    - a. Type: Non-Dispersive Infrared.
    - b. Light Tube Material: Gold-plated.
    - c. Output: 0 to 10 V and 4 to 20 mA.
    - d. Long Term Stability: <5.0% of full scale after five years.
    - e. Response Time: 1 minute.
    - f. Humidity Range: 0 to 85% relative humidity, noncondensing.
    - g. Operating Temperature Range: 23°F to 113°F.
    - h. Storage Temperature Range: -4°F to 158°F.
    - i. Resolution of Analog Outputs: 2.5 ppm CO2.
- F. Room Sensor Cover Construction: Manufacturer's standard locking covers.
1. Set-Point Adjustment: Concealed.
  2. Set-Point Indication: Exposed.
  3. Thermometer: Concealed.
  4. Color: Coordinate with Architect.
  5. Orientation: Vertical.
- G. Room sensor accessories include the following:
1. Insulating Bases: For sensors located on exterior walls.
  2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.
  3. Adjusting Key: As required for calibration and cover screws.

## 2.6 STATUS SENSORS

- A. Status Inputs for Fans: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

- B. Status Inputs for Pumps: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- D. Power Monitoring Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for intended application.
  - 1. Type: Split and solid core.
- E. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- F. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- G. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

## 2.7 FLOW MEASURING STATIONS

- A. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.
  - 1. Available Manufacturers:
    - a. Ebtron
    - b. Air Monitor Corporation.
    - c. Wetmaster Co., Ltd.
  - 2. Casing: Galvanized-steel frame.
  - 3. Flow Straightener: Aluminum honeycomb, 3/4-inch (20-mm) parallel cell, 3 inches (75 mm) deep.
  - 4. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.
- B. Fan Inlet Airflow Station: Face mounted multiple sensors.
  - 1. Available Manufacturer:
    - a. Ebtron
  - 2. Sensor Assembly: Hermetically sealed bead in glass heated element thermistor, glass filled polypropylene sensor housing, marine grade waterproof epoxy potting material.
  - 3. Output: Analog.

4. Accuracy:
5. Cable Assembly: Plenum rated, PVC jacket.
6. Transmitter: BACnet.

## 2.8 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
1. Available Manufacturers:
    - a. Belimo Aircontrols (USA), Inc.
  2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
  3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf.
  4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
  5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
  6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Available Manufacturers:
    - a. Belimo Aircontrols (USA), Inc.
  2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
  3. Dampers: Size for running torque calculated as follows:
    - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
    - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
    - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
    - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
    - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
  4. Coupling: V-bolt and V-shaped, toothed cradle.

5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 24-V ac.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: Minus 22 to plus 122 deg F.
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
12. Run Time: 12 seconds open, 5 seconds closed.

## 2.9 CONTROL VALVES

- A. Control Valves: Factory fabricated, globe type; body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- B. Hydronic system globe valves shall have the following characteristics:
  1. NPS 2 and Smaller: Class 250 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
  2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
  3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
    - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
    - b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
  4. Sizing: 5-psig maximum pressure drop at design flow rate or the following:
    - a. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
    - b. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
  5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
  6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
- C. Terminal Unit Glove Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
  1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.

2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

## 2.10 DAMPERS

- A. Dampers: AMCA-rated, opposed-blade design; 0.108-inch minimum thick, galvanized-steel or 0.125-inch minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.
  1. Secure blades to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
  2. Operating Temperature Range: From minus 40 to plus 200 deg F.
  3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
  4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

## 2.11 CONTROL CABLE

- A. Control Cable: In accordance with Division 27 Section "Communications Copper Horizontal Cabling."

## 2.12 RACEWAYS, BOXES, AND CABINETS

- A. Raceways, Boxes, and Cabinets: In accordance Division 26 Section "Raceway and Boxes for Electrical Systems."

## 2.13 BUILDING WIRE AND CABLE

- A. Building Wire and Cable: In accordance Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## 2.14 VARIABLE FREQUENCY MOTOR CONTROLLERS

- A. Variable Frequency Motor Controllers: In accordance with Division 23 Section "Variable Frequency Motor Controllers."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.

### 3.2 CONTROL DEVICES FOR EQUIPMENT MANUFACTURER FACTORY INSTALLATION

- A. Deliver the following to air-handling unit manufacturer for factory installation. Include installation instructions to air-handling unit manufacturer:

1. Application-specific controller.
2. Unit-mounted DDC control dampers and actuators.
3. Unit-mounted airflow sensors, switches and transmitters.
4. Unit-mounted gas sensors and transmitters.
5. Unit-mounted leak-detection switches.
6. Unit-mounted speed sensors, switches and transmitters.
7. Unit-mounted pressure sensors, switches and transmitters.
8. Unit-mounted temperature sensors, switches and transmitters.

- B. Deliver the following to terminal unit manufacturer for factory installation. Include installation instructions to terminal unit manufacturer.

1. Application-specific controller.
2. Electric damper actuator.
3. Unit-mounted flow and pressure sensors, transmitters and transducers. Flow sensors, transmitters, and transducers.
4. Unit-mounted temperature sensors.
5. Relays.

### 3.3 GENERAL INSTALLATION

- A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats, and other exposed control sensors with Drawings and room details before installation. Install devices 60 inches above the floor.
- D. Install guards on thermostats in the following locations:
  1. Entrances.
  2. Public areas.
  3. Where indicated.

4. Service and maintenance areas.
  5. Indoor Play Areas (Gym)
- E. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- G. Install transient voltage and surge suppressors.
- H. Install power monitoring sensors.
- I. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- J. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
- K. Install electronic and fiber-optic cables according to Division 27 Section "Communications Copper Horizontal Cabling."
- L. Furnish and install variable frequency controllers according to Division 23 Section "Variable Frequency Motor Controllers." Except for packaged unit variable frequency controllers.
- M. Furnish unit controls to Division 23 Section "Outdoor, Central-Station Air Handling Units" manufacturer for factory mounting.
- N. Furnish unit controls to Division 23 Section "Air Terminal Units" manufacturer for factory mounting.

### 3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Division 27 Section "Communications Copper Horizontal Cabling."
1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
  2. Install exposed cable in raceway.
  3. Install concealed cable in raceway.
  4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.

5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
  6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
  7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
  2. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
  3. Test each point through its full operating range to verify that safety and operating control set points are as required.
  4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
  5. Test each system for compliance with sequence of operation.
  6. Test software and hardware interlocks.
- C. DDC Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
  2. Check instruments for proper location and accessibility.
  3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
  4. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
  5. Check temperature instruments and material and length of sensing elements.
  6. Check control valves. Verify that they are in correct direction.
  7. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
  8. Check DDC system as follows:
    - a. Verify that DDC controller power supply is from emergency power supply, if applicable.

- b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
  - c. Verify that spare I/O capacity has been provided.
  - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

### 3.6 ADJUSTING

#### A. Calibrating and Adjusting:

- 1. Calibrate instruments.
- 2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
- 3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
- 4. Control System Inputs and Outputs:
  - a. Check analog inputs at 0, 50, and 100 percent of span.
  - b. Check analog outputs using milliamper meter at 0, 50, and 100 percent output.
  - c. Check digital inputs using jumper wire.
  - d. Check digital outputs using ohmmeter to test for contact making or breaking.
  - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
- 5. Flow:
  - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
  - b. Manually operate flow switches to verify that they make or break contact.
- 6. Pressure:
  - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
  - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
- 7. Temperature:
  - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
  - b. Calibrate temperature switches to make or break contacts.
- 8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
  10. Provide diagnostic and test instruments for calibration and adjustment of system.
  11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to five visits to Project during other than normal occupancy hours for this purpose and up to five visits to Project during normal occupancy hours for this purpose.

### 3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 230900

## SECTION 232113 - HYDRONIC 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. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
  - 1. Hot-water heating piping.
  - 2. Seismic joints.

#### 1.3 DEFINITIONS

- A. PTFE: Polytetrafluoroethylene.
- B. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
- C. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
  - 1. Pressure-seal fittings.
  - 2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
  - 3. Air control devices.
  - 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. Show coordination with work of other trades.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Welding certificates.
- C. Field quality-control test reports.
- D. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.7 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.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications:
  - 1. Installers of Grooved Couplings: Installers shall be certified by the grooved coupling manufacturer for the installation of manufacturer's product.
    - a. Manufacturer's Field Training Program:
      - 1) Onsite Certification Training: Training in use of grooving tools, application of groove, and product installation; provided by manufacturer's factory-trained representative (direct employee) for installing contractor's field personnel in the use
      - 2) Training: Designed, developed, administered, and evaluated in accordance to ANSI/IACET Standard for Continuing Education and Training (IACET-International Association for Continuing Education and Training).
  - 2. 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. Qualification Data: For Installer.
- C. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

- D. 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.
- E. 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.
- F. Date Stamped Castings: All castings used for coupling housings, fittings, and valve bodies shall be date stamped for quality assurance and traceability.

## PART 2 - PRODUCTS

### 2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Fittings: ASME B16.22.
- E. Grooved fittings: Not allowed.
- F. Copper or Bronze Pressure-Seal Fittings: Not allowed.
- G. Copper, Mechanically Formed Tee Option: Not allowed.
- H. Wrought-Copper Unions: ASME B16.22.

### 2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, 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.

## HYDRONIC PIPING

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- D. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
- E. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- F. Wrought Cast- and Forged-Steel Flanges and Flanged 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.
  - 3. Facings: Raised face.
- G. Grooved Mechanical-Joint Fittings and Couplings: Not allowed.
- H. Steel Pressure-Seal Fittings: Not allowed.
- I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

## 2.3 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- D. 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.
- E. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

## 2.4 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 Flanges:

1. Description:

- a. Standard: ASSE 1079.
- b. Factory-fabricated, bolted, companion-flange assembly.
- c. Pressure Rating: 150 psig.
- d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

C. Dielectric-Flange Insulating Kits:

1. Description:

- a. Non-conducting 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.

D. Dielectric Nipples:

1. 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 or grooved.
- e. Lining: Inert and noncorrosive, propylene.

2.5 VALVES

A. Gate, Globe, Check, and Ball, Valves: Comply with requirements specified in Section 230523 "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230900 "Instrumentation and Control for HVAC."

C. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Armstrong Pumps, Inc.
- b. Bell & Gossett Domestic Pump; a division of ITT Industries.
- c. Flow Design, Inc.
- d. Griswold Controls.
- e. Approved equal.

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.
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.

## 2.6 AIR CONTROL DEVICES

### A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/8 (DN 6).
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 225 deg F (107 deg C).

### B. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

## 2.7 AUTOMATIC FLOW CONTROL VALVES:

### 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. FlowCon International
2. Flow Design Inc.
3. Griswold Controls.

### B. Body: Brass or ferrous metal.

### C. Piston and Spring Assembly: Corrosion resistant, tamper proof, self cleaning, and removable.

- D. Combination Assemblies: Include bronze or brass-alloy ball valve.
- E. Identification Tag: Marked with zone identification, valve number, and flow rate.
- F. Size: Same as pipe in which installed.
  - 1. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
  - 2. Minimum CWP Rating: 175 psig.
  - 3. Maximum Operating Temperature: 200 deg F.

## 2.8 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: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
- 4. CWP Rating: 125 psig.

### B. 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: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
- 4. CWP Rating: 125 psig.

### C. Stainless-Steel Bellow, Flexible Connectors:

- 1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
- 2. End Connections: Threaded or flanged to match equipment connected.
- 3. Performance: Capable of 3/4-inch (20-mm) misalignment.
- 4. CWP Rating: 150 psig (1035 kPa).
- 5. Maximum Operating Temperature: 250 deg F (121 deg C).

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Hot-water heating piping, aboveground, NPS 2 and smaller shall be any of the following:
  - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- B. Air-Vent Piping:
  - 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
  - 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- C. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

### 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 calibrated-orifice, balancing valves at each branch connection to return main.
- 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; and 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.

### 3.3 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such 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.

- 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. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."
- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- S. Install shutoff valve immediately upstream of each dielectric fitting.
- T. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown

connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

- U. Identify piping as specified in Section 230553 "Identification for HVAC Piping and Equipment."
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Requirements for HVAC."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Requirements for HVAC."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Requirements for HVAC."

### 3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.
- B. Seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
  - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
  - 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
  - 2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
  - 3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
  - 4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  - 5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
  - 6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.

7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
  8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
- E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
  2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
  3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  4. NPS 2: Maximum span, 8 feet ; minimum rod size, 3/8 inch.
  5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
  6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

### 3.5 PIPE 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 pipe and fittings before assembly.
- C. 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.
- D. 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.
- E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- G. Pressure-Sealed Joints: Not allowed.
- H. Grooved Joints: Not allowed.

### 3.6 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 piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- C. Install air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
- D. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.
- E. Install flex connection at each pump inlet and outlet and as indicated.

### 3.7 SEISMIC JOINT INSTALLATION

- A. Install per manufacturer's recommendations.
- B. Support return bend to allow 100% of the loops indicated movement.

### 3.8 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

### 3.9 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
  - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
  - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
  - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
  - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure or not less 100 psi, the greater of the two shall be used. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

## SECTION 232923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

### 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. Division 23 Section "Instrumentation and Control for HVAC".
  - 2. Division 23 Section "Packaged, Outdoor, Central Station Air Handling Units".

#### 1.2 SUMMARY

- A. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.
- B. VFCs shall be of same model line by a single manufacturer and shall be furnished and installed as part of Division 23 Section "Instrumentation and Control for HVAC". Installation shall include connection between motor and controller unless explicitly indicated otherwise.

#### 1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. CPT: Control power transformer.
- C. EMI: Electromagnetic interference.
- D. IGBT: Insulated-gate bipolar transistor.
- E. LAN: Local area network.
- F. LED: Light-emitting diode.
- G. MCP: Motor-circuit protector.
- H. NC: Normally closed.
- I. NO: Normally open.
- J. OCPD: Overcurrent protective device.

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- K. PID: Control action, proportional plus integral plus derivative.
- L. PWM: Pulse-width modulated.
- M. RFI: Radio-frequency interference.
- N. VFC: Variable-frequency motor controller.
- O. VFD: Variable-frequency drive, alternative description of VFC.

#### 1.4 SUBMITTALS

- A. Product Data: For each type and rating of VFC indicated.
- B. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
  - 1. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Product certificates.
- E. Operation and maintenance data.

#### 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

#### 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB.
  - 2. Package units with factory installed VFCs can be manufacturer's preferred VFC
- B. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- C. Application: Variable torque.
- D. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
  - 1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
  - 2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
  - 3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- F. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- G. Unit Operating Requirements:
  - 1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
  - 2. Input AC Voltage Unbalance: Not exceeding 3 percent.
  - 3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
  - 4. Minimum Efficiency: 96 percent at 60 Hz, full load.
  - 5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
  - 6. Minimum Short-Circuit Current (Withstand) Rating: 10 kA.
  - 7. Ambient Temperature Rating: Not less than 14 deg F and not exceeding 104 deg F.

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8. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F.
  9. Humidity Rating: Less than 95 percent (noncondensing).
  10. Altitude Rating: Not exceeding 3300 feet.
  11. Vibration Withstand: Comply with IEC 60068-2-6.
  12. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
  13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
  14. Speed Regulation: Plus or minus 5 percent.
  15. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
  16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- H. Inverter Logic: Microprocessor based, 16 or 32 bit, isolated from all power circuits.
- I. Isolated Control Interface: Allows VFCs to follow remote-control electrical signal over a minimum 40:1 speed range.
- J. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
  2. Maximum Speed: 80 to 100 percent of maximum rpm.
  3. Acceleration: 0.1 to 999.9 seconds.
  4. Deceleration: 0.1 to 999.9 seconds.
  5. Current Limit: 30 to minimum of 150 percent of maximum rating.
- K. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
  2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
  3. Under- and overvoltage trips.
  4. Inverter overcurrent trips.
  5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
  6. Critical frequency rejection, with three selectable, adjustable deadbands.
  7. Instantaneous line-to-line and line-to-ground overcurrent trips.
  8. Loss-of-phase protection.
  9. Reverse-phase protection.
  10. Short-circuit protection.
  11. Motor overtemperature fault.
- L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

- M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- P. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker or NEMA AB 1, molded-case switch, with power fuse block and current-limiting fuses or NEMA AB 1, thermal-magnetic circuit breaker or NEMA KS 1, nonfusible switch, with power fuse block and current-limiting fuses or NEMA KS 1, fusible switch with pad-lockable, door-mounted handle mechanism.
  - 1. Disconnect Rating: Not less than 115 percent of VFC input current rating.

## 2.2 CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicators displaying the following conditions:
  - 1. Power on.
  - 2. Run.
  - 3. Overvoltage.
  - 4. Line fault.
  - 5. Overcurrent.
  - 6. External fault.
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
  - 1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
  - 2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
    - a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
- C. Historical Logging Information and Displays:
  - 1. Running log of total power versus time.

2. Total run time.
  3. Fault log, maintaining last four faults with time and date stamp for each.
- D. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
1. Output frequency (Hz).
  2. Motor speed (rpm).
  3. Motor status (running, stop, fault).
  4. Motor current (amperes).
  5. Motor torque (percent).
  6. Fault or alarming status (code).
  7. PID feedback signal (percent).
  8. DC-link voltage (V dc).
  9. Set point frequency (Hz).
  10. Motor output voltage (V ac).
- E. Control Signal Interfaces:
1. Electric Input Signal Interface:
    - a. A minimum of two programmable analog inputs: 0- to 10-V dc or 4- to 20-mA dc.
    - b. A minimum of six multifunction programmable digital inputs.
  2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
    - a. 0- to 10-V dc.
    - b. 4- to 20-mA dc.
    - c. Potentiometer using up/down digital inputs.
    - d. Fixed frequencies using digital inputs.
  3. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc or 4- to 20-mA dc, which can be configured for any of the following:
    - a. Output frequency (Hz).
    - b. Output current (load).
    - c. DC-link voltage (V dc).
    - d. Motor torque (percent).
    - e. Motor speed (rpm).
    - f. Set point frequency (Hz).
  4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
    - a. Motor running.
    - b. Set point speed reached.
    - c. Fault and warning indication (overtemperature or overcurrent).

d. PID high- or low-speed limits reached.

- F. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms and energy usage. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
1. Network Communications Ports: Ethernet and RS-422/485.
  2. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet; protocols accessible via the communications ports.

## 2.3 ENCLOSURES

- A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
1. Dry and Clean Indoor Locations: Type 1.
  2. Other Wet or Damp Indoor Locations: Type 3R or Type 4, as required.
  3. Exterior Locations, Including Under Canopy: Type 3R.
- B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

## 2.4 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty type.
    - a. Push Buttons: Shielded types; momentary.
    - b. Pilot Lights: Incandescent or LED types; push to test.
    - c. Selector Switches: Rotary type.
- B. Control Relays: Auxiliary and solid-state time-delay relays.
- C. Monitoring Contacts: Auxiliary dry contacts for monitoring by EMCS as indicated.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. VFD's for use with Division 23 Section "Packaged, Outdoor, Central Station Air Handling Units" shall be furnished to AHU manufacturer for factory installation.
- 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 each fusible-switch VFC.
- E. Install fuses in control circuits if not factory installed.
- F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- H. Comply with NECA 1.

### 3.2 IDENTIFICATION

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Division 23 Section "Identification for HVAC piping & equipment."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each VFC with engraved nameplate.
  - 3. Label each enclosure-mounted control and pilot device.

### 3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic control devices where applicable.

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1. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### 3.4 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.
- D. VFD adjustment will involve a combination of balancer, controls contractor, mechanical contractor and startup/commissioning.
- E. VFD startups will be performed by factory authorized representative.

### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 232923

## SECTION 233113 - METAL DUCTS

### 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. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Double walled duct and fittings.
4. Sheet metal materials.
5. Sealants and gaskets.
6. Hangers and supports.
7. Seismic-restraint devices.

- B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

#### 1.3 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" except sealant class, pressure class, and performance requirements and design criteria shall be as indicated in "Duct Schedule" Article and not on drawings.
- 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."
  1. Seismic Design Category D.

- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of the following products:

1. Sealants and gaskets.
2. Seismic-restraint devices.
3. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

- 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, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

- C. 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 shall 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. Sprinklers.
  - e. Access panels.

- f. Perimeter moldings.

## 1.5 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

## 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.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- a. Lindab Inc.
  - b. McGill AirFlow LLC.
  - c. SEMCO Incorporated.
  - d. Sheet Metal Connectors, Inc.
  - e. Spiral Manufacturing Co., Inc.
- 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 flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct

construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G60.
  - 2. Finishes for Surfaces Exposed to View: Exposed ductwork shall be painted as per specification section 099113.
- C. 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.
- D. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).
- E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in 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.

## 2.4 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: 4 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, stainless steel, or aluminum.
  - 10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 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, stainless steel, or aluminum sheets.

D. 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, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

## 2.5 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 Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
  3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## 2.6 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cooper B-Line, Inc.; a division of Cooper Industries.
  2. Ductmate Industries, Inc.
  3. Gripple, Inc.
  4. Hilti Corp.
  5. Kinetics Noise Control.
  6. Loos & Co.; Cableware Division.
  7. Mason Industries.
  8. TOLCO; a brand of NIBCO INC.
  9. Unistrut Corporation; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
1. 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 shall be subjected.
- 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: Steel tube or steel slotted-support-system sleeve with internally bolted connections 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.

## 2.7 DOUBLE-WALL DUCT AND FITTING FABRICATION

- A. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.
1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches (50 mm) longer than inner duct and insulation and in metal thickness specified for single-wall duct.

2. Insulation: 1-inch- (25-mm-) thick fibrous glass for exhaust and 1-1/2" thick for supply, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.
  - a. Thermal Conductivity (k-Value): 0.26 at 75 deg F (0.037 at 24 deg C) mean temperature.
3. Solid Inner Ducts: Use the following sheet metal thicknesses and seam construction:
  - a. Ducts 3 to 8 Inches (75 to 200 mm) in Diameter: 0.019 inch (0.5 mm) with standard spiral-seam construction.
  - b. Ducts 9 to 42 Inches (225 to 1070 mm) in Diameter: 0.019 inch (0.5 mm) with single-rib spiral-seam construction.
  - c. Ducts 44 to 60 Inches (1120 to 1525 mm) in Diameter: 0.022 inch (0.55 mm) with single-rib spiral-seam construction.
  - d. Ducts 62 to 88 Inches (1575 to 2235 mm) in Diameter: 0.034 inch (0.85 mm) with standard spiral-seam construction.
  - e. Rectangular ducts: 26-18 gage, ASTM A-653 Galvanized interior and exterior shell with 1" insulation (as above). End treatment shall be transverse duct connection.
4. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.

B. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.

1. Solid Inner Ducts: Use the following sheet metal thicknesses:
  - a. Ducts 3 to 34 Inches (75 to 865 mm) in Diameter: 0.028 inch (0.7 mm).
  - b. Ducts 35 to 58 Inches (890 to 1475 mm) in Diameter: 0.034 inch (0.85 mm).
  - c. Ducts 60 to 88 Inches (1525 to 2235 mm) in Diameter: 0.040 inch (1.0 mm)

## 2.8 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, provide products by one of the following:
  - a. CertainTeed Corporation; Insulation Group.
  - b. Johns Manville.
  - c. Knauf Insulation.
  - d. Owens Corning.
  - e. Maximum Thermal Conductivity:
    - 1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.

- 2) Type II, Rigid:  $0.23 \text{ Btu} \times \text{in./h} \times \text{sq. ft.} \times \text{deg F}$  ( $0.033 \text{ W/m} \times \text{K}$ ) at  $75 \text{ deg F}$  ( $24 \text{ deg C}$ ) mean temperature.
2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that shall 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.
  - 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, provide products by one of the following:
    - a. Aeroflex USA Inc.
    - b. Armacell LLC.
    - c. Rubatex International, LLC
  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."

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations.

## METAL DUCTS

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Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round and flat-oval ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

### 3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.
- F. Exposed ductwork shall be painted. Exposed Locker room ducts shall be painted with protective coating – Foster Defense (40-50) or equivalent.

### 3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

### 3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
  - 1. Ducts shall be supported at intervals not to exceed 12 feet
- B. Building Attachments: Fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Do not use powder-actuated concrete.
  - 3. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: 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," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
  - 1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
  - 2. Brace a change of direction longer than 12 feet.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

### 3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for indicated branch, outlet and inlet, and terminal unit connections.

### 3.7 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.
- B. Paint exposed ductwork to match surroundings-color as approved by the Architect.

### 3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
  - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
  - 2. Test the following systems:
    - a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    - b. Supply Ducts with a Pressure Class of 3-Inch wg or less: Test representative duct sections, selected by Architect from sections installed totaling no less than 50 percent of total installed duct area for each designated pressure class.
    - c. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    - d. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed totaling no less than 50 percent of total installed duct area for each designated pressure class.
  - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
  - 4. Test for leaks before applying external insulation.
  - 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
  - 6. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
  - 1. Visually inspect duct system to ensure that no visible contaminants are present.
  - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

- a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system shall be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.9 DUCT CLEANING

- A. Clean duct system(s) before testing, adjusting, and balancing.
- B. Cleaning shall meet WSSP IEQ3.6 requirements.
- C. Clean the following components by removing surface contaminants and deposits:
  - 1. Air outlets and inlets (registers, grilles, and diffusers).
  - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
  - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
  - 4. Coils and related components.
  - 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
  - 6. Supply-air ducts, dampers, actuators, and turning vanes.
  - 7. Dedicated exhaust and ventilation components and makeup air systems.
- D. Material Packaging and Delivery to Site
  - 1. Care shall be taken to prevent damage and ensure cleanliness during transportation and off-loading of all materials.
  - 2. Duct:
    - a. Large duct assemblies and spools shall be capped with polyethylene film to assure that internal surfaces are kept clean and dry.
    - b. Smaller duct pieces (fitting couplings, small lengths) shall be placed in baskets/bins, sealed, and delivered to the project site.
  - 3. AHUs:
    - a. The factory or shop shall wrap Air Handling Units to prevent damage during transportation and off-loading. It is the responsibility of the purchasing contractor to assure that the equipment is properly protected during shipment and arrival.

E. Site Storage

1. On-Site Storage: The area provided for storage shall be clean and dry with dust exposure minimized. It is the responsibility of the general contractor to maintain proper housekeeping requirements. The general contractor shall be responsible for temperature and humidity monitoring to assure that site conditions are maintained which shall minimize the potential for microbial growth.
2. Off-Site Storage: The area provided for storage shall be clean and dry with exposure to dust minimized.
3. Duct:
  - a. For smaller duct stored in baskets/bins, only the duct that is needed shall be removed and installed while the remainder shall be covered in the basket to prevent contamination.
  - b. In the case of large duct assemblies and spools, the ends shall be kept sealed until they are installed.
  - c. Jobsite duct material storage areas should be located away from high dust generating processes. Vacuum tools shall be provided during high dust generating activities including concrete drilling/grinding and drywall sanding.
  - d. Ducts shall be stored to prevent damage from standing water and weather.
  - e. If there is a risk of water from above or dusty areas cannot be avoided, a protection plan shall be established specific to the site conditions and shall be used to protect the stored materials.
4. AHUs:
  - a. If there is a risk of water on site, or dusty areas cannot be avoided, additional coverage shall be used to protect the AHU's.

F. Installation

1. The working area shall be clean, dry, and protected from the elements.
2. Building water control is the responsibility of the General Contractor. Water must be controlled before scheduled start-work date. The General Contractor shall sweep using sweeping compound to eliminate dust.
3. Duct:
  - a. Individual duct sections shall be inspected to ensure that they are clean and free from all debris that they are dry, and that exposed sound liner edges are properly protected.
  - b. The internal surfaces of the un-insulated ductwork shall be wiped immediately prior to installation, if required, to assure that the surface is adequately clean.
  - c. Open ends on completed ductwork including diffusers and overnight work-in-progress shall be sealed.
  - d. All risers shall be covered to prevent the entry of debris into the duct.
  - e. Installed ductwork must be protected from moisture. Should duct insulation material become exposed to moisture, the material must be dried completely within 24 hours or replaced.

- f. All other trades that need to interact with duct systems, (i.e. drill into or mount devices on duct, work inside duct, or any other activity that could compromise the clean condition of the system) shall need to coordinate this work with the HVAC contractor so as not to compromise the integrity of the protected system.
  - g. It is the duty of the general contractor to ensure the building shall be kept dry during ductwork installation. If at any time, water infiltrates the ductwork once installed, the ductwork shall be visually inspected immediately. If sound lined duct becomes wet, the section of insulation that is wet shall be removed. If non-lined ductwork has water enter the inside of the duct, the ductwork shall be wiped down.
- 4. AHUs:
  - a. After the AHU's are set on the roof, the factory wrap shall remain in place until AHU's are assembled or duct connections are made.
  - b. If there is a risk of water from above or dusty areas cannot be avoided, coverage shall be used to protect AHU's.
  - c. AHU doors shall be locked until power and/or control wiring requires access to the inside of the AHUs. Trades requiring access to equipment shall need to schedule it with the HVAC contractor to assure equipment stays clean. Good housekeeping must be demonstrated while performing work.

G. On-Site VOC Standards

- 1. Adhesives, sealants, paints, and coatings of all kinds used on-site shall comply with VOC limits for LEEDv2009 IEQc4.1 and IEQc4.2.
- 2. Safety data sheets for the products that shall be used on site shall be submitted for approval and these sheets shall be highlighted with compliant VOC grams/liter content.
- 3. Any systems that may be required to operate prior to occupancy (when directed by the owner/general contractor) shall have MERV 8 filters installed in order to meet the LEED certification requirements of the project.
- 4. Filters shall be changed as needed to keep the equipment and ductwork as dust-free as possible.
- 5. Mechanical contractor shall provide documentation about filters including product literature, MERV rating, location, and replacement date.
- 6. All filters shall be replaced prior to occupancy with the filters intended for occupancy.

H. HVAC Operation Post Construction

- 1. Mechanical contractor and the GC shall collectively determine when the jobsite is substantially clean and ready for HVAC operation.
- 2. Filters intended for occupancy shall be installed prior to any HVAC operation, including air balancing and IAQ flush-out (if applicable).

I. Jobsite Cleanup

- 1. Good housekeeping procedures must be followed by all trades in order to minimize the potential contamination of the duct system. This is the responsibility of the General Contractor to assure that this occurs.

J. Inspection and Photo Documentation

1. Photos documenting the implementation of the construction IAQ management measures, such as pre-install cleaning/inspection, protection of ducts and on-site stored materials, shall be recorded weekly and available for review by the general contractor.

K. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3.10 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.

B. Supply Ducts:

1. Ducts Connected downstream of Terminal Units (VAV-X):
  - a. Pressure Class: Positive 1-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 6.
  - d. SMACNA Leakage Class for Round and Flat Oval: 6.
2. Ducts Connected to Variable-Air-Volume Air-Handling Units:
  - a. Pressure Class: Positive 4-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 6.
  - d. SMACNA Leakage Class for Round and Flat Oval: 6.
3. Ducts Connected to Equipment Not Listed Above:
  - a. Pressure Class: Positive 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 6.
  - d. SMACNA Leakage Class for Round and Flat Oval: 6.

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C. Return Ducts:

1. Ducts Connected to Air-Handling Units:
  - a. Pressure Class: Negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 6.
  - d. SMACNA Leakage Class for Round and Flat Oval: 6.
2. Ducts Connected to Equipment Not Listed Above:
  - a. Pressure Class: Negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: a.
  - c. SMACNA Leakage Class for Rectangular: 6.
  - d. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
  - a. Pressure Class: Negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 6.
  - d. SMACNA Leakage Class for Round and Flat Oval: 6.
2. Ducts Connected to Commercial Kitchen Hoods (Type I & Type II), Clothes Dryer, and Fume Hood Exhaust: Comply with NFPA 96.
  - a. Exposed to View: Type 304, stainless-steel sheet, No. 3 finish.
  - b. Concealed: Type 304, stainless-steel sheet, No. 2D finish.
  - c. Welded seams and joints.
  - d. Pressure Class: Positive or negative 3-inch wg .
  - e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
  - f. SMACNA Leakage Class: 3.
  - g. Minimum thickness: 0.0450 inch (18 gauge).

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
2. Stainless-Steel Ducts:
  - a. Exposed to Airstream: Match duct material.
  - b. Not Exposed to Airstream: Match duct material.
3. Aluminum Ducts: Aluminum.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
  - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
  - b. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
  - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".
    - 1) Radius-to Diameter Ratio: 1.5.
  - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
  - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
  - a. Rectangular Main to Rectangular Branch: 45-degree entry.
  - b. Rectangular Main to Round Branch: 45-degree entry.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
  - a. Velocity 1000 fpm or Lower: 90° tee with oval to round tap.
  - b. Velocity 1000 to 1500 fpm: 90° tee with oval to round tap.
  - c. Velocity 1500 fpm or Higher: 90° tee with oval to round tap.

3.12 COMMISSIONING

- A. The equipment and systems referenced in this section are to be commissioned per Section 019113 – General Commissioning Requirements and Section 230800 – Commissioning of HVAC. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION 233113

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## SECTION 233300 - AIR DUCT ACCESSORIES

### 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. Backdraft.
  - 2. Pressure relief access door
  - 3. Manual volume dampers.
  - 4. Control dampers.
  - 5. Fire dampers.
  - 6. Combination fire and smoke dampers.
  - 7. Flange connectors.
  - 8. Turning vanes.
  - 9. Duct-mounted access doors.
  - 10. Flexible connectors.
  - 11. Flexible ducts.
  - 12. Duct accessory hardware.
  - 13. Duct Silencers.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. 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. Control damper installations.
    - d. Fire-damper installations, including sleeves; and duct-mounted access doors.
    - e. Wiring Diagrams: For power, signal, and control wiring.

- C. Operation and maintenance data.

#### 1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. 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: G60.
  - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- 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.

#### 2.2 BACKDRAFT DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Air Balance Inc.; a division of Mestek, Inc.
  - 2. Greenheck Fan Corporation.

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3. Nailor Industries Inc.
4. Pottorff; a division of PCI Industries, Inc.
5. Ruskin Company.

- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 1-inch wg.
- E. Frame: 0.052-inch thick, galvanized sheet steel, with welded corners and mounting flange.
- F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch width, 0.025-inch thick, roll-formed aluminum with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Neoprene, mechanically locked.
- I. Blade Axles:
1. Material: Nonferrous metal.
  2. Diameter: 0.20 inch.
- J. Tie Bars and Brackets: Aluminum.
- K. Return Spring: Adjustable tension.
- L. Bearings: Steel ball or synthetic pivot bushings.
- M. Accessories:
1. Adjustment device to permit setting for varying differential static pressure.
  2. Counterweights and spring-assist kits for vertical airflow installations.
  3. Electric actuators.
  4. Chain pulls.
  5. Front of rear screens.
  6. 90-degree stops.
- N. Sleeve: Minimum 20-gage thickness.

## 2.3 PRESSURE RELIEF ACCESS DOOR

- A. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
  2. Door: Double wall with metal thickness applicable for duct pressure class.

## AIR DUCT ACCESSORIES

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3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set to activate at a 0.5" higher than duct static pressure clarification.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch thick, fibrous-glass or polystyrene-foam board.

## 2.4 MANUAL VOLUME DAMPERS

### A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Air Balance Inc.; a division of Mestek, Inc.
  - b. Flexmaster U.S.A., Inc.
  - c. METALAIRE, Inc.
  - d. Nailor Industries Inc.
  - e. Pottorff; a division of PCI Industries, Inc.
  - f. Ruskin Company.
  - g. Trox USA Inc.
  - h. Vent Products Company, Inc.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
  - a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
  - b. Mitered and welded corners.
  - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
  - a. Multiple or single blade.
  - b. Parallel- or opposed-blade design.
  - c. Stiffen damper blades for stability.
  - d. Galvanized-steel, 0.064 inch thick.
6. Blade Axles: Galvanized steel.
7. Bearings:
  - a. Oil-impregnated bronze.
  - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

B. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Air Balance Inc.; a division of Mestek, Inc.
  - b. Flexmaster U.S.A., Inc.
  - c. METALAIRE, Inc.
  - d. Nailor Industries Inc.
  - e. Pottorff; a division of PCI Industries, Inc.
  - f. Ruskin Company.
  - g. Trox USA Inc.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
  - a. Multiple or single blade.
  - b. Parallel- or opposed-blade design.
  - c. Stiffen damper blades for stability.
  - d. Roll-Formed Aluminum Blades: 0.10-inch thick aluminum sheet.
  - e. Extruded-Aluminum Blades: 0.050-inch thick extruded aluminum.
6. Blade Axles: Galvanized steel.
7. Bearings:
  - a. Oil-impregnated bronze.
  - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Aluminum.

C. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

## 2.5 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Flexmaster U.S.A., Inc.
2. Greenheck Fan Corporation.
3. Lloyd Industries, Inc.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Ruskin Company.

- B. Frames:

1. Hat shaped.
2. Galvanized-steel channels, 0.064 inch thick.
3. Mitered and welded corners.

- C. Blades:

1. Multiple blade with maximum blade width of 8 inches.
2. Parallel- and opposed-blade design.
3. Galvanized steel.
4. 0.064 inch thick.
5. Blade Edging: Closed-cell neoprene edging.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

- D. Blade Axles: 1/2-inch diameter; galvanized steel blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

- E. Bearings:

1. Oil-impregnated bronze.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

## 2.6 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Ductmate Industries, Inc.
  - 2. Nexus PDQ; Division of Shilco Holdings Inc.
  - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

## 2.7 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Ductmate Industries, Inc.
  - 2. Duro Dyne Inc.
  - 3. METALAIRE, Inc.
  - 4. SEMCO Incorporated.
  - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
  - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

## 2.8 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Cesco Products; a division of Mestek, Inc.
  - 2. Ductmate Industries, Inc.

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3. Flexmaster U.S.A., Inc.
4. Greenheck Fan Corporation.
5. Nailor Industries Inc.
6. Pottorff; a division of PCI Industries, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," 7-3, "Access Panels - Round Duct," and 8-15 "Double Wall Duct Access Doors."

1. Door:
  - a. Double wall, rectangular.
  - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
  - c. Vision panel.
  - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
  - e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
  - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
  - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
  - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
  - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

## 2.9 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Ductmate Industries, Inc.
  2. Flame Gard, Inc.
  3. 3M.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
- D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

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## 2.10 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Ductmate Industries, Inc.
  2. Duro Dyne Inc.
  3. Ventfabrics, Inc.
  4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd.
  2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd.
  2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
  3. Service Temperature: Minus 50 to plus 250 deg F.
- G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
  2. Outdoor 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. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
  7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

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## 2.11 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Flexmaster U.S.A., Inc.
  - 2. McGill AirFlow LLC.
  - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helical ly wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
  - 1. Pressure Rating: 4-inch wg (1000 Pa) positive and 0.5-inch wg (125 Pa) negative.
  - 2. Maximum Air Velocity: 4000 fpm (20 m/s).
  - 3. Temperature Range: Minus 20 to plus 175 deg F (Minus 29 to plus 79 deg C).
  - 4. Insulation R-Value: Comply with Washington State Energy Code.
- C. Flexible Duct Connectors:
  - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches to suit duct size.

## 2.12 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## 2.13 REMOTE DAMPER OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. Pottorff.
  - 2. Ventfabrics, Inc.
  - 3. Young Regulator Company.
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Brass or Aluminum.
- D. Cable: Stainless steel.

- E. Surface Mounting: Recessed.
- F. Surface Cover-Plate Material: Steel, painted to match adjacent surface.

## 2.14 DUCT SILENCERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Price
  - 2. Vibro-Acoustics
  - 3. VAM Systems
- B. General Requirements:
  - 1. Factory fabricated.
  - 2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
  - 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Shape:
  - 1. Rectangular straight with splitters or baffles.
  - 2. Rectangular elbow with splitters or baffles.
- D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G60, galvanized sheet steel. See schedule for gauge thickness.
- E. Inner Casing and Baffles: ASTM A 653/A 653M, G60 galvanized sheet metal, 22 gauge (Unless noted otherwise on schedule) and with 1/8-inch- (3-mm-) diameter perforations.
- F. Connection Sizes: Match connecting ductwork unless otherwise indicated. Match outer dimension of overall ductwork for lined ductwork.
- G. Principal Sound-Absorbing Mechanism:
  - 1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
  - 2. Dissipative type with fill material.
    - a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 5 percent compression.
    - b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.

- 3. Lining: None.
- H. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
  - 1. Joints: Lock formed and sealed
  - 2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
  - 3. Reinforcement: Cross or trapeze angles for rigid suspension.
- I. Accessories:
  - 1. Factory-installed end caps to prevent contamination during shipping.
  - 2. Removable splitters.
- J. Source Quality Control: Test according to ASTM E 477.
  - 1. Testing to be witnessed by Architect.
  - 2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm (10-m/s) face velocity.
  - 3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg (1500-Pa) static pressure, whichever is greater.
- K. Capacities and Characteristics: See Schedule

## 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. 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. Install steel volume dampers in steel ducts.
  - 2. Install aluminum volume dampers in aluminum ducts.
  - 3. Volume dampers not required between AHU discharge and VAV terminal units.
- D. Set dampers to fully open position before testing, adjusting, and balancing.

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- E. Install test holes at fan inlets and outlets and elsewhere as indicated.
- F. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. 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.
  - 2. Install pressure relief access door between air handling unit and first wall and/or floor penetration.
  - 3. Elsewhere as indicated.
- G. Install access doors with swing against duct static pressure.
- H. 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.
- I. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- J. Install flexible connectors to connect ducts to equipment.
- K. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- L. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- M. Connect diffusers or light troffer boots to low-pressure ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- N. Connect flexible ducts to metal ducts with liquid adhesive plus tape.
- O. Install duct test holes where required for testing and balancing purposes.
- P. 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.
- Q. Install pressure relief access door between unit connection and first branch on supply and return for each air handling unit (AHU).

- R. Install acoustic turning vanes in all supply, return, and exhaust system mitered elbows 45 degrees and larger and as indicated. Do not install turning vanes in commercial kitchen hood exhaust duct.

### 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 performed.
3. Operate fire 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.

### 3.3 COMMISSIONING

#### A. Commissioning Authority

1. The commissioning authority (CA) has been contracted directly with the owner for this project. The CA has overall responsibility for planning and coordinating the commissioning process. However, commissioning involves all parties involved with the design and construction process, including the mechanical contractor, and all specialty sub-contractors within Division 23, such as sheet metal, piping, refrigeration, water treatment, TAB and controls, plus major equipment suppliers as required.

END OF SECTION 233300

## SECTION 233423 - HVAC POWER VENTILATORS

### 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 include the following:
  - 1. Division 07 Sections "Sheet Metal Flashing", "Styrene-butadiene-styrene (SBS) Modified Bituminous Membrane Roofing," and "Roof Accessories" for manufactured curbs.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Centrifugal roof ventilators.
  - 2. Ceiling-mounted ventilators.
  - 3. In-line centrifugal fans.
  - 4. Fan accessories.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

#### 1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
  - 1. Certified fan performance curves with system operating conditions indicated.
  - 2. Certified fan sound-power ratings.
  - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
  - 4. Material thickness and finishes, including color charts.
  - 5. Dampers, including housings, linkages, and operators.
  - 6. Roof curbs.
  - 7. Fan speed controllers.

- B. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

## 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- C. UL Standard: Power ventilators shall comply with UL 705.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

## 1.7 COORDINATION

- A. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

## 1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Belts: One sets for each belt-driven unit.

## PART 2 - PRODUCTS

### 2.1 CEILING-MOUNTING VENTILATORS

- A. Description: Centrifugal fans designed for installing in ceiling or wall, or for concealed in-line applications.
  - 1. Manufacturers:
    - a. Panasonic.
  - 2. Housing: Steel, Rust proof paint
  - 3. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

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4. Grille: PP.
5. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
6. Accessories:
  - a. Isolation: Rubber-in-shear vibration isolators.
  - b. Manufacturer's standard roof cap with curb or wall cap, and transition fittings.

## 2.2 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Install all fans per manufacturer's installation instructions.
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

### 3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
1. Verify that shipping, blocking, and bracing are removed.
  2. Verify that unit is secure on mountings and supporting devices, and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  3. Verify that cleaning and adjusting are complete.
  4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  5. Adjust belt tension.
  6. Adjust damper linkages for proper damper operation.
  7. Verify lubrication for bearings and other moving parts.
  8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
  9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
  10. Shut unit down and reconnect automatic temperature-control operators.
  11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

### 3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION 233423

## SECTION 233600 - AIR TERMINAL UNITS

### 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. Division 23 Section "Instrumentation and Control for HVAC".

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Shutoff, single-duct air terminal units.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: 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 ASCE/SEI 7.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
  - 1. Air terminal units.
  - 2. Liners and adhesives.
  - 3. Sealants and gaskets.
  - 4. Seismic-restraint devices.
- B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:

1. Materials, fabrication, assembly, attachment to structure, and spacing of hangers and supports.
2. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.
2. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

E. Wall Elevation Drawings: 1/4" scale elevation drawing of each room with diffuser terminal showing unit lengths, accessories and filler panels.

F. Field quality-control reports.

G. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.1 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Environmental Technologies, Inc.
2. Nailor Industries Inc.

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3. Titus.
  4. Price Industries
  5. Krueger
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: 22 gauge zinc coated steel double wall.
1. Casing Lining: Adhesive attached, 3/4-inch-thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
  2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
  3. Air Outlet: S-slip and drive connections.
  4. Access: Removable panels, bottom mounted, for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
  5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
- E. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
- F. Direct Digital Controls: Factory mount actuator specified in Section 230900 "Instrumentation and Control for HVAC."

## 2.2 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. Steel Cables: Galvanized steel complying with ASTM A 603.
- D. 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.
- E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

- F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

## 2.3 SEISMIC-RESTRAINT DEVICES

- A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
  - 1. 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 will be subjected.
- B. 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.
- C. 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; with an automatic-locking and clamping device or double-cable clips.
- D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- E. 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.

## 2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to ARI 880.
  - 1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. 24"x24" access panels shall be provided for terminal units mounted above hard ceilings.

## AIR TERMINAL UNITS

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### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
  - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.3 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with ASCE/SEI 7.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on air terminal units that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
  - 1. Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect 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. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

### 3.4 CONNECTIONS

- A. Install piping adjacent to air terminal unit to allow service and maintenance.
- B. Chilled-Water and Hot-Water Piping: In addition to requirements in Section 232113 "Hydronic Piping," connect heating and cooling coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- C. Connect ducts to air terminal units according to Section 233113 "Metal Ducts."
- D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

### 3.5 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

### 3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
  1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
  2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
  3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Air terminal unit will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports.

### 3.7 CONTROLS

- A. Factory install controls furnished as part of Division 23 Section "Instrumentation and Control for HVAC."

### 3.8 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
  - 3. Verify that controls and control enclosure are accessible.
  - 4. Verify that control connections are complete.
  - 5. Verify that nameplate and identification tag are visible.
  - 6. Verify that controls respond to inputs as specified.

### 3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

## SECTION 233713 - 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. Square ceiling diffusers.
  - 2. Linear slot diffusers.
  - 3. Adjustable bar registers and grilles.
  - 4. Drum Louver

#### 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.

### PART 2 - PRODUCTS

#### 2.1 CEILING DIFFUSERS

- A. Square Ceiling Diffusers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carnes.
    - b. Titus.
    - c. Price.
    - d. Krueger
  - 2. Material: Steel.
  - 3. Finish: Baked enamel, white.
  - 4. Characteristics: See Drawings

## 2.2 CEILING LINEAR SLOT OUTLETS

### A. Linear Bar Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carnes.
  - b. Titus.
  - c. Price.
2. Characteristics: As indicated.

### B. Linear Slot Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carnes.
  - b. Titus.
  - c. Price.
  - d. Krueger
2. Devices shall be specifically designed for variable-air-volume flows.
3. Characteristics: As indicated.

## 2.3 REGISTERS AND GRILLES

### A. Adjustable and Fixed Bar Registers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carnes.
  - b. Titus.
  - c. Price
  - d. Krueger
2. Characteristics: As indicated.

## 2.4 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 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.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

#### 3.2 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

## SECTION 237413 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

### 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 230548 - Vibration and Seismic Controls for HVAC Piping and Equipment.
  - 2. Section 230900 - Instrumentation and Control for HVAC.
  - 3. Section 233300 - Air Duct Accessories.

#### 1.2 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
  - 1. Direct-expansion cooling.
  - 2. Gas furnace.
  - 3. Economizer outdoor- and return-air damper section.
  - 4. Roof curbs.

#### 1.3 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

- F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design RTU supports to comply with wind and seismic performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Wind-Restraint Performance:
  - 1. Basic Wind Speed: 130 MPH per current ASCE 7-10.
  - 2. Building Classification Category: III.
- C. Seismic Performance: RTUs 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."

#### 1.5 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
  - 2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

3. Wind and Seismic Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  1. Structural members to which RTUs will be attached.
  2. Roof openings.
  3. Roof curbs and flashing.
- B. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Manufacturer Seismic Qualification Certification: Submit certification that RTUs, accessories, and components will withstand seismic forces defined in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Field quality-control test reports.
- E. Warranty: Special warranty specified in this Section.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fan Belts: One set for each belt-driven fan.
  - 2. Filters: One set of filters for each unit.

1.9 QUALITY ASSURANCE

- A. ARI Compliance:
  - 1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
  - 2. Comply with ARI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
  - 1. Comply with ASHRAE 15 for refrigeration system safety.
  - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
  - 3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- E. UL Compliance: Comply with UL 1995.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
  - 2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.
  - 3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.

4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Daikin.

### 2.2 PACKAGED ROOF MOUNTED OUTDOOR CENTRAL STATION AHU

- A. General Description:

1. Except as noted, packaged rooftop unit to include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, gas heaters, exhaust fans, energy recovery wheels, indirect natural gas-fired heaters, exhaust fans and unit controls.
2. Factory assembled and tested including leak testing of the DX coils, pressure testing of refrigeration circuit, run testing of completed unit. Run test report supplied with unit in service compartment's literature pocket.
3. Decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
4. Labeled unit components, including refrigeration system components and electrical and controls components.
5. Estimated sound power levels (dB) shown on unit ratings sheet.
6. Installation, Operation, and Maintenance manual shall be supplied within unit.
7. Laminated color-coded wiring diagram to match factory installed wiring and affixed to interior of control compartment's hinged access door.
8. Unit nameplate in two locations on unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.
9. Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated for access to internal parts and components, with joints between sections sealed.

- B. Construction:

1. All cabinet walls, access doors, and roof fabricated of double wall, impact resistant, rigid polyurethane foam panels.
2. Minimum unit thermal resistance R-value of 13. Minimum density of 2 pounds/cubic foot foam insulation, tested in accordance with ASTM D1929-11 for minimum flash ignition temperature of 610°F.
3. Double wall with G90 galvanized steel on both sides unit construction, thermal break.

4. Cabinet leakage not to exceed 1% of total airflow when tested at 3 times minimum external static pressure per AHRI Standard 340/360. Maximum panel deflection not to exceed L/240 ratio at 125% of design static pressure up to maximum 8 inches of positive or negative static pressure.
5. Sloped air tunnel roof for complete drainage. Rain break overhangs above access doors.
6. Hinged access doors with quarter turn, lockable handles at filter, damper, cooling coil, heat exchanger, exhaust fan, energy recovery wheel, compressor locations. and electrical and controls components. Full length stainless steel piano hinges.
7. Exterior paint finish capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
8. Double sloped 304 stainless steel drain pans in units with cooling coils.
9. Base discharge and return air openings.
10. Lifting lugs on the top of unit.

C. Motors and Fans

1. Direct drive, unhooded, backward curved, plenum supply fans.
2. Belt driven unhooded, backward curved plenum or belt driven forward curved exhaust fans.
3. Blowers and motors dynamically balanced and mounted on rubber isolators.
4. Premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.

D. Variable Frequency Drives

1. Factory wired and mounted in unit with operating and construction as indicated in Section 232923 "Variable Frequency Motor Controllers." Fan motors shall be premium efficiency.

E. Evaporator Coils

1. Designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to tubes and galvanized steel end casings. Sine wave rippled.
2. Interlaced circuitry.

F. Refrigeration System

1. Factory charged with R-410A refrigerant.
2. Scroll type compressors, thermal overload protection, 5 year non-prorated warranty, from the date of original equipment shipment from the factory.
3. Compressors mounted in an isolated service compartment accessible without affecting unit operation. Lockable hinged compressor access doors fabricated of double wall, rigid polyurethane foam injected panels.
4. Expansion type refrigerant flow control at each refrigeration circuit.

5. Automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both high pressure and low pressure sides, factory installed replaceable core liquid line filter driers on each refrigeration circuit.
6. Variable capacity scroll compressor on lead refrigeration circuits capable of modulation from 10-100% on multiple circuit units.
7. Liquid line sight glass at each refrigeration circuit.
8. First capacity stage provided with on/off condenser fan cycling and adjustable compressor lockout to allow cooling operation down to 35°F.

G. Air Cooled Condensers

1. Vertical discharge condenser fans, axial flow, direct drive fans.
2. Multi-pass coils, fabricated from aluminum microchannel tubes.
3. 10°F of refrigerant sub-cooling.
4. Coils hydrogen or helium leak tested.

H. Indirect-Fired Gas Heat Exchanger

1. Stainless steel heat exchanger with 25 year non-prorated warranty, from date of original equipment shipment.
2. Stainless steel heat exchangers with multiple concavities, induced draft blower, electronic pressure switch to lockout gas valve until combustion chamber is purged and combustion airflow is established.
3. Gas ignition system consisting of electronic igniter to pilot system, continuous when the heater is operating, shut off the pilot when heating not required.
4. Single gas connection, gas supply piping entrances in unit base for through-curb gas piping, in outside cabinet wall for across roof gas piping.
5. Modulating gas valve(s), adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller. Combustion blowers and gas valves shall capable of modulation. Factory wired electronic controller, field installed supply air temperature sensor located in supply air ductwork. Adjustable supply air temperature setpoint. Gas heating assemblies up to 404 MBH input capable of operating at any firing rated between 100% and 30% of rated capacity. Gas heating assemblies 405 MBH input and larger capable of operating at any firing rate between 100% and 20% of rated capacity.

I. Economizer Section

1. 0-100% economizer consisting of motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Gear driven damper blades with have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across damper. Class 2 low leakage dampers AMCA certified per AMCA Standard 511. Spring return enthalpy activated fully modulating actuator. Outside air opening bird screen, outside air hood, barometric relief dampers.

J. Filters

1. 4 inch thick, pleated panel filters, 85% ASHRAE efficiency, MERV rating of 13, upstream of the cooling coil. 2 inch thick, pleated panel pre filters 30% ASHRAE efficiency, MERV rating of 8, upstream of 4 inch standard filters.

K. Energy Recovery

1. Factory mounted and tested energy recovery wheel mounted in rigid frame containing wheel drive motor, drive belt, wheel seals and bearings. Frame slide out for service and removal from cabinet.
2. Wheel shall be wound from aluminum heat transfer matrix, continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow and minimum pressure drop-to-efficiency ratios. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.
3. Removable energy transfer matrix. Welded hub, spoke and rim assembly of stainless, plated and/or coated steel wheel frame. Self-supporting without matrix segments in place. Segments removable without tools. Wheel bearings with L-10 life in excess of 400,000 hours. Continuous rolled stainless steel rim. Wheel connected to shaft by means of taper locks.
4. Factory set seals. Drive belts of stretch urethane wheel rim drive without need for external tensioners or adjustment.
5. UL listed energy recovery cassette. Thermal performance shall be certified in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. AHRI Certified Cassettes.
6. Cassette with 5 year non-prorated warranty, from the date of original equipment shipment from the factory. Warranty excludes parts associated with routine maintenance parts excluded.
7. 2 inch thick, pleated panel pre filters 30% ASHRAE efficiency, MERV rating of 8, upstream of wheels.
8. Hinged service access doors at wheel.
9. Total energy recovery wheels coated with ceramic dessicant matrix permanently bonded without use of binders or adhesives, which may degrade desiccant performance. Lightweight polymer substrate. Washable coated segments with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in presence of water or high humidity.

L. Controls

1. Factory mount controls furnished to unit manufacturer by Division 230900 "Instrumentation and Control for HVAC" supplier.

## 2.3 ACCESSORIES

- A. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- B. Hail guards of galvanized steel, painted to match casing.
- C. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

## 2.4 RESTRAINED ISOLATION ROOF-CURB RAILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. California Dynamics Corporation.
  - 2. Kinetics Noise Control, Inc.
  - 3. Mason Industries, Inc.
- B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb designed to resiliently support equipment and to withstand seismic and wind forces.
- C. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces.
- D. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
- E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
- F. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed w237413ood nailer; complying with NRCA standards.
  - 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
    - a. Materials: ASTM C 1071, Type I or II.
    - b. Thickness: 1 inch.
  - 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

- a. Liner Adhesive: Comply with ASTM C 916, Type I.
  - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
  - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
  - d. Liner Adhesive: Comply with ASTM C 916, Type I.
- G. Overall Curb Height: Height as indicated on plans.
- H. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.
- 2.5 CAPACITIES AND CHARACTERISTICS – As indicated in Mechanical Schedule.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Equipment Mounting:
  - 1. Install AHU's on vibration isolation type curb.
- B. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof

Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

- C. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure AHU's to structural support with anchor bolts.
  - 1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

### 3.3 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- B. Install piping adjacent to RTUs to allow service and maintenance.
  - 1. Gas Piping: Comply with applicable requirements in Section 231123 "Facility Natural-Gas Piping. Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
- C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
  - 1. Install ducts to termination at top of roof curb.
  - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
  - 3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
  - 4. Install return-air duct continuously through roof structure.

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.
- C. Tests and Inspections:
  - 1. After installing RTUs 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.
- D. Remove and replace malfunctioning units and retest as specified above.

### 3.5 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 and do the following:
1. Inspect for visible damage to unit casing.
  2. Inspect for visible damage to furnace combustion chamber.
  3. Inspect for visible damage to compressor, coils, and fans.
  4. Inspect internal insulation.
  5. Verify that labels are clearly visible.
  6. Verify that clearances have been provided for servicing.
  7. Verify that controls are connected and operable.
  8. Verify that filters are installed.
  9. Clean condenser coil and inspect for construction debris.
  10. Clean furnace flue and inspect for construction debris.
  11. Connect and purge gas line.
  12. Remove packing from vibration isolators.
  13. Inspect operation of barometric relief dampers.
  14. Verify lubrication on fan and motor bearings.
  15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
  16. Adjust fan belts to proper alignment and tension.
  17. Start unit according to manufacturer's written instructions.
    - a. Start refrigeration system.
    - b. Do not operate below recommended low-ambient temperature.
    - c. Complete startup sheets and attach copy with Contractor's startup report.
  18. Inspect and record performance of interlocks and protective devices; verify sequences.
  19. Operate unit for an initial period as recommended or required by manufacturer.
  20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
    - a. Measure gas pressure on manifold.
    - b. Inspect operation of power vents.
    - c. Measure combustion-air temperature at inlet to combustion chamber.
    - d. Measure flue-gas temperature at furnace discharge.

- e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
  - f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
21. Calibrate thermostats.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
- a. Coil leaving-air, dry- and wet-bulb temperatures.
  - b. Coil entering-air, dry- and wet-bulb temperatures.
  - c. Outdoor-air, dry-bulb temperature.
  - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
- a. Supply-air volume.
  - b. Return-air volume.
  - c. Relief-air volume.
  - d. Outdoor-air intake volume.
27. Simulate maximum cooling demand and inspect the following:
- a. Compressor refrigerant suction and hot-gas pressures.
  - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
- a. High-temperature limit on gas-fired heat exchanger.
  - b. Low-temperature safety operation.
  - c. Filter high-pressure differential alarm.
  - d. Economizer to minimum outdoor-air changeover.
  - e. Relief-air fan operation.
  - f. Smoke and firestat alarms.
29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

- 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 two visits to site during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 237413

## SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Building wires and cables rated 600 V and less.
  - 2. Connectors, splices, and terminations rated 600 V and less.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.1 CONDUCTORS AND 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. Alpha Wire.
  - 2. Belden Inc.
  - 3. Encore Wire Corporation.
  - 4. General Cable Technologies Corporation.
  - 5. Southwire Incorporated.
- B. Aluminum and Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-THWN, Type XHHW-2.
- D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with ground wire.

## 2.2 CONNECTORS AND SPLICES

- 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. AFC Cable Systems, Inc.
  - 2. Gardner Bender.
  - 3. Hubbell Power Systems, Inc.
  - 4. Ideal Industries, Inc.
  - 5. IlSCO; a branch of Bardes Corporation.
  - 6. NSi Industries LLC.
  - 7. O-Z/Gedney; a brand of the EGS Electrical Group.
  - 8. 3M; Electrical Markets Division.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

## 2.3 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

## PART 3 - EXECUTION

### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper for feeders smaller than No. 4 AWG; aluminum for feeders No. 4 AWG and larger. All feeder conductors shall be copper up to 100Amps and copper or compact aluminum above 100Amps; aluminum conductors shall not be allowed for branch circuit wiring.
- B. Branch Circuits: Copper. Stranded.

### 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.

- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- E. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway, Metal-clad cable, Type MC. MC Cable shall not be used for multi-wire branch circuits, nor in any location in the kitchen environment. MC cable shall not be used in walls under the exterior windows.
- G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- H. Dedicated neutrals will be provided in multi-wire branch circuit runs.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. 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.
- C. 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.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- G. Provide an individual neutral conductor for each single hot (phase) wire. Do not share neutrals.
- H. Multiconductor cable: Rigid raceways must be used between panelboards and rooms, and must terminate in the ceiling space at a j-box. Multiconductor cable may only be used from this j-box to devices.

### 3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

### 3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

### 3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

END OF SECTION 260519

## SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
  - 1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

#### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. RMC: Rigid metal conduit.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- B. 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.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Steel slotted support systems.

- B. Shop Drawings: 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. Equipment supports.

## 1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.

## 1.7 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.

## PART 2 - PRODUCTS

### 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. ERICO International Corporation.
    - d. GS Metals Corp.
    - e. Thomas & Betts Corporation.
    - f. Unistrut; Tyco International, Ltd.
    - g. Wesanco, Inc.
  2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  3. 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 hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. 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:
      - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
      - 2) Empire Tool and Manufacturing Co., Inc.
      - 3) Hilti Inc.
      - 4) MKT Fastening, LLC.
  - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
  - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  - 5. Toggle Bolts: All-steel springhead type.
  - 6. Hanger Rods: Threaded steel.

### PART 3 - EXECUTION

#### 3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT and RMC as required by NFPA 70 unless noted otherwise. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Conduits shall be supported within 18" of outlets, boxes, panels, cabinets. Maximum distance between supports is not to exceed 5'-0". Prevent movement and / or sag of junction boxes, pull boxes, or other conduit terminating housings located above suspended ceilings by suspending them from appropriate supports or roof structure.

- D. 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.

### 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
  2. To New Concrete: Bolt to concrete inserts.
  3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  4. To Existing Concrete: Expansion anchor fasteners.
  5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts. To Light Steel: Sheet metal screws.
  6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### 3.3 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

- B. Touchup: Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior 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 260529

## SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

- B. Related Requirements:

1. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
2. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

#### 1.3 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.
- B. IMC: Intermediate metal conduit.
- C. EMT: Electrical metallic tubing.
- D. FMC: Flexible metal conduit.
- E. LFMC: Liquidtight flexible metallic conduit.
- F. PVC: Rigid Polyvinyl Chloride conduit.
- G. RNC: Rigid Nonmetallic conduit.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, hinged-cover enclosures, and cabinets.

### PART 2 - PRODUCTS

#### 2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems, Inc.
  2. Allied Tube & Conduit; a Tyco International Ltd. Co.
  3. O-Z/Gedney; a brand of EGS Electrical Group.
  4. Southwire Company.
  5. Thomas & Betts Corporation.
  6. Western Tube and Conduit Corporation.
- B. Listing and Labeling: Metal 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. GRC: Comply with ANSI C80.1 and UL 6.
- D. IMC: Comply with ANSI C80.6 and UL 1242.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. FMC: Comply with UL 1; zinc-coated steel.
- G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Fittings for EMT:
    - a. Material: Steel.
    - b. Type: compression.
  2. 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.
- I. Joint Compound for IMC, GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems, Inc.
  2. Anamet Electrical, Inc.
  3. Arnco Corporation.
  4. CANTEX Inc.
  5. CertainTeed Corp.
  6. Condux International, Inc.
  7. Electri-Flex Company.
  8. Kraloy.
  9. Lamson & Sessions; Carlon Electrical Products.
  10. Niedax-Kleinhuis USA, Inc.
  11. RACO; a Hubbell company.
  12. Thomas & Betts Corporation.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. Fittings for RNC: Comply with NEMA TC 3; match to conduit type and material.
- E. 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).

## 2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- 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. Cooper B-Line, Inc.
  2. Hoffman; a Pentair company.
  3. Square D; a brand of Schneider Electric.
- B. Description: Sheet metal, complying with NEMA 250, Type 1 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.

## 2.4 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Panduit Corp.
    - b. Thomas & Betts Corporation.
    - c. Wiremold / Legrand.

## 2.5 BOXES, ENCLOSURES, AND CABINETS

- 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. Adalet.
  - 2. Cooper Technologies Company; Cooper Crouse-Hinds.
  - 3. FSR Inc.
  - 4. Hoffman; a Pentair company.
  - 5. Hubbell Incorporated; Killark Division.
  - 6. Mono-Systems, Inc.
  - 7. O-Z/Gedney; a brand of EGS Electrical Group.
  - 8. RACO; a Hubbell Company.
  - 9. Thomas & Betts Corporation.
  - 10. 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. 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.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

- H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- I. Device Box Dimensions: 4 inches square by 1-1/2 inches deep.
- J. Signal System Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- K. Floor Boxes: Provide floor boxes locations per electrical and communications drawings. All floor boxes shall be code-approved metal construction, with gasketed metal covers, flush with floor grade (even in use). Manufacturers: Wiremold Omnibox Series or Hubbell with adjustable collars and frames, or approved by Beaverton School District Representative. Minimum floor box requirements: 3 7/16" deep with 1" factory knockouts
- L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

### PART 3 - EXECUTION

#### 3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Exposed Rooftop Conduit: IMC.
  - 2. Concealed Conduit, Aboveground: EMT.
  - 3. Underground Conduit: Type EPC-40-PVC, direct buried.
  - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC, no more than 6 feet.
  - 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 and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
  - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet

locations. Sealtite shall be used where flexible conduit connections are required and at connections to all motorized equipment and motors.

5. Damp or Wet Locations: GRC.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

D. 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. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
4. All heavy wall conduits shall have two locknuts and a bushing at each termination outlet box, junction box, except where terminated in a threaded hub.

E. Install surface raceways only where indicated on Drawings. Use metallic raceway.

F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

G. Exposed low voltage cables are not allowed to be supported from electrical conduit system.

H. Conduit bodies are allowed for feeders and branch circuits less than or equal to 100 amps and for signal cabling not related to data communications.

### 3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter.
- 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 and communications conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction. Conduit bends shall be made with appropriate tools of proper size; radius of bends shall be at least six times the diameter of the conduit.

- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated.
- H. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- I. Bushings and connectors shall be plastic insulated, lined, 105degC rated. A bushing shall be used where conduit enters a panelbox.
- J. 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 5-foot intervals.
  - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
  - 3. Provisions shall be made to assure a minimum cover of 2" of concrete.
- 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. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- M. 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.
- N. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- O. 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.
- P. 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 an underground service raceway enters a building or structure.
  - 2. Where otherwise required by NFPA 70.
- Q. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

R. Expansion-Joint Fittings:

1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
2. 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.
3. Fittings shall be type "AX" or "TX" as made by O-Z Electric Company, or equal. Provide copper bonding jumper at each expansion fitting.

S. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC in damp or wet locations not subject to severe physical damage.

T. 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.

U. 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.

V. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

W. Locate boxes so that cover or plate will not span different building finishes.

X. 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.

Y. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

Z. Set metal floor boxes level and flush with finished floor surface.

### 3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill.
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.

4. 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.
5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."
6. A minimum of 18" of cover ground shall be provided.
7. PVC conduit shall transition with 90 deg GRC bend where it emerges from the ground or concrete in all locations which it is installed.

### 3.4 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.
- B. Install handholes and boxes as required to avoid exceeding maximum allowed bends for raceways.
- C. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, 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.
- D. 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.
- E. 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.

### 3.5 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."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

END OF SECTION 260533

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND  
CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

## 2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  - 1. Manufacturers: Subject to compliance with requirements, 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. 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: Carbon steel.
  - 4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

## 2.3 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.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

- a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
  - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
  4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
  5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

## SECTION 260548.16 - SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Channel support systems.
  - 2. Hanger rod stiffeners.
  - 3. Anchorage bushings and washers.
- B. Related Sections include the following:
  - 1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

#### 1.3 DEFINITIONS

- A. The IBC: International Building Code.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
  - 1. Basic Wind Speed: 115 MPH.
  - 2. Building Classification Category: III.
  - 3. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction and 45 degrees either side of normal.
- B. Seismic-Restraint Loading:
  - 1. Site Class as Defined in the IBC: D.
  - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
    - a. Component Importance Factor: 1.0.
    - b. Component Response Modification Factor: 1.5.
    - c. Component Amplification Factor: 1.0.

3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 143% of 6.
4. Design Spectral Response Acceleration at 1.0-Second Period: 56% of 6.

## 1.5 ACTION SUBMITTALS

### A. Product Data: For the following:

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 seismic-restraint component used.
  - 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.
  - b. Annotate to indicate application of each product submitted and compliance with requirements.
3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

### B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Field-fabricated supports.

## 1.6 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Comply with NFPA 70.

## PART 2 - PRODUCTS

### 2.1 VIBRATION ISOLATORS

- 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. Ace Mountings Co., Inc.
  2. Amber/Booth Company, Inc.
  3. California Dynamics Corporation.
  4. Isolation Technology, Inc.
  5. Kinetics Noise Control.
  6. Mason Industries.
  7. Vibration Eliminator Co., Inc.
  8. Vibration Isolation.
  9. Vibration Mountings & Controls, Inc.
- B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene.
- C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
  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.

### 2.2 SEISMIC-RESTRAINT 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. Amber/Booth Company, Inc.
  2. California Dynamics Corporation.

3. Cooper B-Line, Inc.; a division of Cooper Industries.
  4. Hilti Inc.
  5. Loos & Co.; Seismic Earthquake Division.
  6. Mason Industries.
  7. TOLCO Incorporated; a brand of NIBCO INC.
  8. Unistrut; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an evaluation service member of ICC-ES.
1. 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 will be subjected.
- C. Channel Support System: MFMA-3, shop- or field-fabricated support 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; and rated in tension, compression, and torsion forces.
- D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.
- F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
- G. 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.
- H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

### PART 3 - EXECUTION

#### 3.1 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners 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 will be adequate to carry present and future static and seismic loads within specified loading limits.

#### 3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
  - 1. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.
- B. 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.
- C. 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.
- D. 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

### 3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

END OF SECTION 260548.16

## SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Identification for conductors.
  - 2. Underground-line warning tape.
  - 3. Warning labels and signs.
  - 4. Equipment identification labels.
  - 5. Arc Flash label per NEC.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

#### 1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.

#### 1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Labeling is to be reviewed and approved by the Facilities Project Manager & Electrical Supervisor.
- C. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- D. Coordinate installation of identifying devices with location of access panels and doors.

- E. Install identifying devices before installing acoustical ceilings and similar concealment.
- F. Panels require labeling of necessary PPE with potential hazards as a result of Arc Flash Hazard Analysis. The Arc Flash Hazard Analysis shall be performed by the Electrical Contractor.

## PART 2 - PRODUCTS

### 2.1 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

### 2.2 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
  - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
  - 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
  - 3. Nominal size, 7 by 10 inches (180 by 250 mm).
- D. Warning label and sign shall include, but are not limited to, the following:
  - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

### 2.3 EQUIPMENT IDENTIFICATION LABELS

- A. Normal Power Equipment: Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a black background. Minimum letter height shall be 3/8 inch (10 mm).
- B. Emergency Power Equipment: Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a red background. Minimum letter height shall be 3/8 inch (10 mm).

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. If banks of switching are installed that control various systems (i.e. lighting, AV, and projection screen, etc.) or various spaces (i.e. classroom and corridor, etc.) labeling with 1/8" black letters indicating function of each switch is required.
- C. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

### 3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. Emergency Power: White letters on a red background.
  - 2. Power: White letters on a black background.
- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
  - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
    - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
    - b. Colors for 208/120-V Circuits:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Phase C: Blue.
      - 4) Neutral: White.
      - 5) Ground: Green.
    - c. Colors for 480/277-V Circuits:

- 1) Phase A: Brown.
  - 2) Phase B: Orange.
  - 3) Phase C: Yellow.
  - 4) Neutral: Gray.
  - 5) Ground: Green.
- d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- C. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification. Install engraved label on the inside of flush panels, visible when the door is open.
1. Labeling Instructions:
    - a. Indoor Equipment: Engraved, laminated acrylic or melamine label, black with white core. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
    - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
  2. Equipment to Be Engraved Labeled:
    - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer, with separate columns for odd and even numbers, using final building room numbers and identifications. Panelboard identification shall be engraved, laminated acrylic or melamine label. Panelboard label shall identify panel, voltage, and electrical source. Each electrical panel ID should start with number where "2" will indicate 208/120V system and "4" will indicate 480/277V system.
    - b. Enclosures and electrical cabinets.
    - c. Access doors and panels for concealed electrical items.
    - d. Emergency system boxes and enclosures.
    - e. Enclosed switches.
    - f. Enclosed circuit breakers.
    - g. Enclosed controllers.
    - h. Variable-speed controllers.
    - i. Push-button stations.
    - j. Power transfer equipment.
    - k. Contactors.
    - l. Remote-controlled switches, dimmer modules, and control devices.
    - m. Monitoring and control equipment.

3. On the cover of junction and pull boxes, use label, or legibly write with indelible ink, the panel number, circuit number and voltage for each box.
4. On the back of wiring devices including power receptacles and switches, use label, or legibly write with indelible ink, the panel number, circuit number and voltage for each wiring device.
5. Contractor to supply (2) laminated one-line diagrams showing disconnects with Record Drawings for posting in main electrical room and emergency room.

END OF SECTION 260553

## SECTION 260800 – COMMISSIONING OF ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. The purpose of this section is to specify the Contractor's responsibilities relative to Division 26 and participation in the commissioning process. See Division 1, Section 019113, "General Commissioning Requirements," for Contractor-related commissioning requirements.
- B. Organization of the commissioning program is primarily the responsibility of the Commissioning Authority. Execution of the program is primarily the responsibility of the Contractor with support from the Division 26 for:
  - 1. Testing and start-up of the electrical equipment.
  - 2. Completion and endorsement of prefunctional test checklists provided by the Commissioning Authority to assure that Division 26 equipment and systems are fully operational and ready for functional testing.
  - 3. Providing qualified personnel to assist the Commissioning Authority with functional testing to verify equipment/system performance.
  - 4. Providing equipment, materials, and labor necessary to correct deficiencies found during the commissioning process which fulfill contract and warranty requirements.
  - 5. Providing training for the systems specified in Division 26 with coordination of Owner by the Commissioning Authority.
- C. Division 26 shall cooperate with the Commissioning Authority in the following manner:
  - 1. Allow sufficient time before final completion dates so that electrical testing, lighting control checkout, and functional testing can be accomplished.
  - 2. Provide labor and material to make corrections when required without undue delay.
  - 3. Put all electrical systems and equipment into full operation and continue the operation of the same during each working day of commissioning.
- D. Related Sections
  - 1. Section 019113 – General Commissioning Requirements
  - 2. Division 22 - Plumbing
  - 3. Division 23 - HVAC

## PART 2 - PRODUCTS

### 2.1 TEST EQUIPMENT

- A. Standard certified test equipment for commissioning will be provided by the Commissioning Authority.
- B. Proprietary test equipment required by the manufacturer shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist the Commissioning Authority in the commissioning process.

## PART 3 - EXECUTION

### 3.1 WORK PRIOR TO COMMISSIONING

- A. Specific pre-commissioning responsibilities of Division 26 are as follows:
  - 1. Normal start-up services required to bring each system into a fully operational state.
  - 2. Execute functional tests and complete prefunctional test checklists for the following equipment and systems:
    - a. Support of mechanical systems
    - b. Lighting control systems
    - c. Day lighting control system
    - d. Portions of mechanical equipment start-up requiring electrical connections and metering.
    - e. Factory start-up services for key equipment and systems specified in Division 26. The Division 26 Contractor shall coordinate this work with the manufacturer and the Commissioning Authority.
    - f. Emergency power system and restart testing.
    - g. Ground Fault Protection test
    - h. Metering system

### 3.2 PARTICIPATION IN COMMISSIONING

- A. The Division 26 Contractor shall provide skilled technicians to start up and debug all systems within the Division 26 work (particularly with lighting equipment). These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc., will be requested by the Commissioning Authority and coordinated by the Contractor. Contractor will ensure the qualified technician(s) are available and present during the agreed upon schedules, and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.

- B. The Commissioning Authority reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment, system, and/or sub-system. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment, and an attitude/willingness to work with the Commissioning Authority to get the job done. A liaison or intermediary between the Commissioning Authority and qualified factory representatives does not constitute the availability of a qualified technician for purposes of this work.

### 3.3 WORK TO RESOLVE DEFICIENCIES

- A. Maladjustments, misapplied equipment, and/or deficient performance under varying loads will result in a system that does not meet Acceptable Performance. Correction of work will be completed under the direction of the Architect, with input from the Contractor, Equipment Supplier, and Commissioning Authority. Whereas all members will have input and the opportunity to discuss, debate, and work out problems, the Architect/Engineer-of-Record will have final jurisdiction on the necessary work to be done to achieve performance and/or design intent.

### 3.4 ELECTRICAL SYSTEM TESTING

- A. Electrical system testing as required in other sections of this specification shall be coordinated with the Commissioning Authority. The Commissioning Authority may witness testing performed by the Division 26 Contractor.
- B. All testing documentation related to Division 26 equipment and systems, as specified in other sections of this specification, will be provided to the Commissioning Authority for use and review.

### 3.5 SEASONAL COMMISSIONING AND OCCUPANCY VARIATIONS

- A. Seasonal commissioning pertains to testing under full-load conditions during peak heating and peak cooling seasons, as well as part-load conditions in the spring and fall. Initial commissioning will be done as soon as contract work is completed regardless of season. All equipment and systems will be tested and commissioned in a peak season to observe full-load performance. Heating equipment will be tested during winter design extremes. Cooling equipment will be tested during summer design extremes, with a fully occupied building. The Contractor will be responsible to participate in the initial and the alternate peak season test of the systems required demonstrating performance.
- B. Subsequent commissioning may be required under conditions of minimum and/or maximum occupancy or use. All equipment and systems affected by occupancy variations will be tested and commissioned at the minimum, and at peak loads to observe system performance. The Contractor will be responsible to participate in the occupancy sensitive testing of systems to provide verification of adequate performance.

3.6 TRAINING

- A. The Division 26 Contractor will be required to participate in the training of the Owner's engineering and maintenance staff for each electrical system and the related components. Training may be conducted in a classroom setting, with system and component documentation, and suitable classroom training aids, or in the field with the specific equipment. The type of training will be per the Owner's option.

END OF SECTION 260800

## SECTION 260923 - LIGHTING CONTROL DEVICES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. Standalone daylight-harvesting switching controls.
4. Indoor occupancy sensors.
5. Outdoor motion sensors.
6. Lighting contactors.
7. Emergency shunt relays.

- B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, and manual light switches.

#### 1.3 PRE-SUBMITTAL MEETING

- A. A Representative for the company of the lighting controls to be installed shall have a pre-submittal meeting with the Electrical Engineer to discuss the design intent as shown on the construction documents and how it may be affected by system specific requirements, including but not limited to device locations and types, wiring diagrams, and system commissioning requirements.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
  1. Interconnection diagrams showing field-installed wiring.
  2. Include diagrams for power, signal, and control wiring.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 LIGHTING CONTROL UNITS

- A. Basis-of-Design Product: Provide Wattstopper DLM, no substitutions.
- B. System Description: Stand alone, multi zone lighting control interface to provide control coordination between all classroom (or similar spaces) lighting controls. The system shall provide coordination for the following controls.
  - 1. Occupancy Sensors: The classroom occupancy sensors shall connect to control unit. Classroom lighting shall be switched by control unit based on occupancy sensor signals.
  - 2. Photocells: Control unit shall interface with photocell in each classroom to dim lighting automatically with significant daylight. Control unit must have a minimum dimming time delay of 30 seconds to avoid changing state during passing clouds or other brief sun obstruction events. During times of peak sunlight, lights shall dim to minimum state instead of switching off to avoid classroom distractions caused by automatic switching.
  - 3. Wall Dimmers: Manual wall dimmers shall connect to control unit to provide dimming override of lighting, not allowing light levels to exceed automatic daylight dimmed levels.
  - 4. Lighting Fixtures: Control unit shall provide dimming control of 0-10V dimming drivers for LED fixtures.  
Network wiring: All Lighting Control Units shall be capable of providing status and trending data back to centralized PC via wired or wireless connection.
- C. System programming is done with hand-held remote-control tool, iphone application, or central computer system.
- D. Commissioning: Upon completion of installation, a factory representative shall come to the site to provide final programming and owner training for all classroom lighting control units.
- E. Wall-Switch Dimmer Tag  $S_{LVD}$ :
  - 1. Basis of design: Wattstopper LMDM-101.
  - 2. Voltage: 24V from DLM Network.
  - 3. Display: LED bar graph for relative light level.

## LIGHTING CONTROL DEVICES

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4. Program to single touch raise to full/dim to off; hold for raise and lower.

F. Wall-Switch Dimmer Tag S<sub>5</sub>:

1. Basis of design: Wattstopper LMSW-105.
2. Voltage: 24V from DLM Network
3. Display: LED status indicator
4. Program scene buttons to control different scenes or loads; turn lights on or off with the paddle

## 2.2 DAYLIGHT-HARVESTING SWITCHING CONTROLS

- A. Basis-of-Design Product: Provide photocell compatible with Lighting Control Unit Described in section 2.1 of this article.
- B. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, to detect changes in indoor lighting levels that are perceived by the eye.
- C. Electrical Components, Devices, and Accessories:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
  3. Sensor Output: Low voltage digital or analog signal compatible Lighting Control Unit. Sensor is powered by Lighting Control Unit.
  4. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lux), with an adjustment for turn-on and turn-off levels within that range.
  5. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc (1080 to 10 800 lux), with an adjustment for turn-on and turn-off levels within that range.
  6. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lux), with an adjustment for turn-on and turn-off levels within that range.
  7. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
  8. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
  9. Test Mode: User selectable, overriding programmed time delay to allow settings check.
  10. Control Load Status: User selectable to confirm that load wiring is correct.

## 2.3 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. Basis-of-Design Product: Provide photocell compatible with Lighting Control Unit Described in section 2.1 of this article.
- B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
1. Lighting control set point is based on two lighting conditions:

- a. When no daylight is present (target level).
  - b. When significant daylight is present.
- C. Ceiling-Mounted Dimming Controls Tag P<sub>D</sub>: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.
  - 1. Basis of design: Wattstopper LMLS-500.
  - 2. Voltage: 24V from DLM Network.
  - 3. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 4. Sensor Output: Low voltage digital signal compatible with Lighting Control Unit. Sensor is powered by Lighting Control Unit.
  - 5. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).

## 2.4 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Provide Wattstopper, no substitutions.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Operation:
    - a. Common Spaces: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable, set to 15 minutes.
    - b. Classrooms: Unless otherwise indicated, configure for vacancy sensing. Lights are to be turned on manually, and the occupancy sensor will turn them off when unoccupied; with a time delay for turning lights off, adjustable, set to 15 minutes.
  - 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
  - 4. Power Pack (where required): Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
  - 5. Mounting:
    - a. Sensor: Suitable for mounting in any position on a standard outlet box.
    - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
    - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

C. Ceiling Sensor Tag OS<sub>D</sub>:

1. Basis of design: Wattstopper LMDC-100.
2. Standard Range: 360-degree field of view with a minimum coverage area of 900 sq. ft. (84 sq. m).
3. Sensing Technology: Dual technology - PIR and ultrasonic.
4. Voltage: 24V from DLM Network.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

D. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.

E. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

F. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

## 2.5 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Manufacturers: Provide Wattstopper, no substitutions.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
  1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
  3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
- C. Wall-Switch Sensor Tag S<sub>OS</sub>:
  1. Basis of design: Wattstopper DW-100.
  2. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. (84 sq. m).
  3. Sensing Technology: Dual technology - PIR and ultrasonic.
  4. Switch Type: SP.
  5. Voltage: 120 V; dual-technology type.
  6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
  7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
  8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

## 2.6 EMERGENCY SHUNT RELAY

- 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. Watt Stopper.

- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

- 1. Coil Rating: 120 or 277 V.

## 2.7 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## PART 3 - EXECUTION

### 3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

### 3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

### 3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non power-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

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- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

### 3.4 COMMISSIONING

- A. The lighting controls shall be programmed to behave as follows:

1. Classrooms: The classroom contains four dimming zones 'a', 'b', 'c1' and 'c2' are controlled via a wall/dimmer switch by classroom entry and also a 5-button scene control by the teacher's station. Zones 'a' and 'c1' are in daylight zone. Zones 'b' and 'c2' are in general lighting zone. Zones 'c1' and 'c2' can be controlled together separately from zones 'a' and 'b' for presentation or whiteboard mode. Daylight zones shall dim in response to the photocell to maintain 40 footcandles measures at the students desk level. The occupancy sensors shall turn lights off automatically (manual-on/auto-off). When the rooms are un-occupied for 10 min lights cycle off. When the building arms, classroom lights cycle off.
2. Corridors: Lighting in this space is controlled by relay via timeclock with after hours override by automatic occupancy sensors. Photocells shall control lighting in the space to maintain 20 footcandles. No additional commissioning is required for automatic dimming.
3. Restrooms: Occupancy sensing only. The occupancy sensor shall turn lights on and off automatically.
4. Exterior Lighting:
  - a. Exterior building mounted lights to be turned "ON" 30 minutes before sunset by astronomical clock and turned "OFF" 15 minutes after the building is armed by security keypad. Provide integration of lighting control and intrusion detection system.
  - b. Dark campus during night time with exception of exterior lights dedicated to School Signage which need to be "ON" from dusk to dawn.

- B. Networking of digital controls:

1. Digital controls are located in Classrooms, Shared Learning Spaces, and anywhere else with a lighting control unit. All digital lighting control units shall be networked together and tied back to existing segment manager to enable metering by a personal.
2. Non digital controls (restrooms etc) do not need to be networked.

### 3.5 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
1. Identify controlled circuits in lighting contactors.
  2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

- B. Label time switches and contactors with a unique designation.

### 3.6 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
  - 2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.

### 3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 260923

## SECTION 262726 - WIRING DEVICES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
  - 2. Tamper-resistant receptacles.
  - 3. Snap switches and wall-box dimmers.
  - 4. Wall-switch occupancy sensors.
  - 5. Communications outlets.

#### 1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. SPD: Surge protection device.
- F. UTP: Unshielded twisted pair.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
  - 2. Cord and Plug Sets: Match equipment requirements.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Manufacturers' 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.

## 2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

## 2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Hubbell; HBL5351 (single), HBL5352 (duplex).
    - b. Leviton; 5891 (single), 5352 (duplex).
    - c. Pass & Seymour; 5361 (single), 5362 (duplex).

## 2.4 GFCI RECEPTACLES

### A. General Description:

1. Straight blade, non-feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

### B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Hubbell; GFR5352L.
  - b. Pass & Seymour; 2095.
  - c. Leviton; 7590.

### C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Hubbell; HBL8300SGA.
  - b. Leviton; 8300-SGG.
  - c. Pass & Seymour; TR63H.

### D. Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Hubbell; GFTR20.
  - b. Pass & Seymour; 2095TR.

## 2.5 TOGGLE SWITCHES

### A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

### B. Switches, 120 V, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Single Pole:

- 1) Hubbell; HBL1221.
- 2) Leviton; 1221-2.
- 3) Pass & Seymour; CSB20AC1.

b. Two Pole:

- 1) Hubbell; HBL1222.
- 2) Leviton; 1222-2.
- 3) Pass & Seymour; CSB20AC2.

c. Three Way:

- 1) Hubbell; HBL1223.
- 2) Leviton; 1223-2.
- 3) Pass & Seymour; CSB20AC3.

d. Four Way:

- 1) Hubbell; HBL1224.
- 2) Leviton; 1224-2.
- 3) Pass & Seymour; CSB20AC4.

C. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide the following:
  - a. Pass & Seymour; no substitution.
2. Description: Momentary contact switch key for heavy-duty locking switch, 500K, with district-wide key standardization

2.6 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Satin-finished type 302 stainless steel, beveled edge.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

2.7 FINISHES

A. Device Color:

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1. Wiring Devices Connected to Normal Power System: Gray unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. Wiring Devices Connected to Stand-By Generator Power Panelboards: Blue.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
  2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
  1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
  2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
- D. Device Installation:
  1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
  2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
  3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
  4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
  5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

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.

### 3.2 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle. On the back of finish plate, use a label, or legibly write indelible ink, the panel number, circuit number and voltage for each box.

END OF SECTION 262726

## SECTION 265100 - INTERIOR LIGHTING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Interior solid-state luminaires that use LED technology.
  - 2. Exit signs.
  - 3. Lighting fixture supports.

- B. Related Sections:

- 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including lighting control units, photoelectric sensors, and occupancy sensors.

#### 1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. LER: Luminaire efficacy rating.
- D. Lumen: Measured output of lamp and luminaire, or both.
- E. Luminaire: Complete lighting fixture, including ballast housing if provided.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
  - 1. Physical description of lighting fixture including dimensions.
  - 2. Driver.
  - 3. Energy-efficiency data.
  - 4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
  - a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
- B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.
  1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples: For each lighting fixture indicated in the Interior Lighting Fixture Schedule. Each
- D. Installation instructions.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.
- B. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.
- C. Field quality-control reports.
- D. Warranty: Sample of special warranty.

#### 1.6 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.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Drivers and LED boards for downlights: Provide 5 extra drivers and led boards for adjustable CCT downlights. Provide 2 extra drivers for detention grade fixtures.

## 1.8 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 lighting 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.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

## 1.10 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

## 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.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products indicated on Drawings or a prior approved equal.

### 2.2 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."

### 2.3 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 for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. Recessed Fixtures: Comply with NEMA LE 4.
- E. Bulb shape complying with ANSI C79.1.
- F. Lamp base complying with ANSI C81.61.
- G. CRI of minimum of 80. CCT variable or as called out on fixture schedule.
- H. Rated lamp life of 50,000 hours.
- I. Lamps dimmable from 100 percent to 10 percent of maximum light output.
- J. Internal driver.
- K. Nominal Operating Voltage: 120 V ac.
  - 1. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

## INTERIOR LIGHTING

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## 2.4 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. 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.

### C. 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 for all luminaires.

## 2.5 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.

## 2.6 LUMINAIRE FIXTURE 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.
- B. Single-Stem Hangers: 1/2-inch (13-mm) 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 gage (2.68 mm).
- D. Rod Hangers: 3/16-inch (5-mm) 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.

## PART 3 - EXECUTION

### 3.1 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 fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 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: LEDs, 50,000 hours minimum rated lamp life.

### 3.3 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.

### 3.4 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install per manufacturer's requirements.
- D. Install lamps in each luminaire.
- E. 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 vertical force of 400 percent of luminaire weight.

- F. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

### 3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.6 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.

### 3.7 STARTUP SERVICE

- A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in LED fixtures intended to be dimmed, for at least 100 hours at full voltage.

END OF SECTION 265100

## SECTION 265600 - EXTERIOR LIGHTING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Exterior luminaires with lamps and ballasts.
  - 2. Luminaire-mounted photoelectric relays.
  - 3. Luminaire lowering devices.

- B. Related Sections:

- 1. Section 265100 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

#### 1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. LER: Luminaire efficacy rating.
- D. Luminaire: Complete lighting fixture, including ballast housing if provided.
- E. Pole: Luminaire support structure, including tower used for large area illumination.
- F. Standard: Same definition as "Pole" above.

#### 1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
- B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4-M.

- C. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.
- D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
  - 1. Basic wind speed for calculating wind load for poles exceeding 49.2 feet (15 m) in height is 100 mph (45 m/s).
    - a. Wind Importance Factor: 1.0.
    - b. Minimum Design Life: 50 years.
    - c. Velocity Conversion Factors: 1.0.
  - 2. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 100 mph (45 m/s).
    - a. Wind Importance Factor: 1.0.
    - b. Minimum Design Life: 25 years.
    - c. Velocity Conversion Factors: 1.0.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
  - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
  - 2. Details of attaching luminaires and accessories.
  - 3. Details of installation and construction.
  - 4. Luminaire materials.
  - 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
    - a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
  - 6. Photoelectric relays.
  - 7. Ballasts, including energy-efficiency data.
  - 8. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
  - 9. Materials, dimensions, and finishes of poles.
  - 10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
  - 11. Anchor bolts for poles.
  - 12. Manufactured pole foundations, if indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires to include in emergency, operation, and maintenance manuals.

#### 1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Lamps: One for every 100 of each type and rating installed. Furnish at least one of each type. None required for LEDs.

#### 1.9 QUALITY ASSURANCE

- A. 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.
- 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 IEEE C2, "National Electrical Safety Code."
- D. Comply with NFPA 70.

#### 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.
  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 year(s) from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products indicated on Drawings or a prior approved equal.

### 2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
  1. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
  2. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
  3. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.

- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field. Shields for LED fixtures shall be integrated into the individual LED optics.
- J. 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.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. 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.
- M. Factory-Applied Finish for Steel luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
  - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    - a. Color: As selected from manufacturer's standard catalog of colors.
- N. Factory-Applied Finish for Aluminum luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
- O. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
  - 1. Label shall include the following lamp and ballast characteristics:

- a. "USES ONLY" and include specific lamp type.
- b. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
- c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
- d. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
- e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
- f. CCT and CRI for all luminaires.

## 2.3 LED SYSTEMS

- A. The LED module itself and all its components must not be subjected to mechanical stress.
- B. Assembly must not damage or destroy conducting patches on the circuit board.
- C. Installation of LED modules (with power supplies) shall adhere to all applicable electrical and safety standards.
- D. Correct electrical polarity shall be clearly identified.
- E. LED module must be protected from unbalanced voltage drop, and/or overload.
- F. Ensure that the power supply is of adequate power to operate the total load.
- G. Utilized ESD precautions when installing the module.
- H. Install system according to the manufacturer's heat sinking parameters.
- I. For applications involving exposure to humidity and dust, the module shall be protected by a fixture or housing with a suitable protection glass. The module shall be protected against condensation water by treatment with an appropriate circuit board conformal coating. The conformal coating should have the following features:
  1. Optical transparency.
  2. UV resistance.
  3. Thermal expansion properties matching those of the module.
  4. Low permeability of steam for all climate conditions.
  5. Resistance against corrosive environments.
- J. The LED module shall be operated with an electronically stabilized power supply including protection against short circuits, overload, and overheating.
- K. All LED products shall have a UL listed label. Unlicensed products are not acceptable.

## 2.4 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
  - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

## 2.5 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

## 2.6 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
- C. 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.

## PART 3 - EXECUTION (NOT USED)

END OF SECTION 265600

## SECTION 270000 - COMMUNICATIONS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. Division 27 – Communications governs the infrastructure for the low-voltage information transport systems, which include voice and data and their pathways.
- B. The Scope of Work covered by this document is to furnish and install the Structured Cabling Systems (SCS). This work will also provide the SCS for paging and video surveillance.
- C. Description of Work:
  - 1. Furnish and install materials for the communications infrastructure systems as specified herein and as shown on the Drawings. Upon completion, the systems shall be functioning in compliance with performance requirements specified.
  - 2. The cabling specified and shown on the Drawings is for complete, performance based, workable systems. Deviations from the cabling shown due to a particular manufacturer's requirements shall be made only with the written approval of the Architect and the Owner, and at no additional cost to the Owner.

#### 1.2 SECTION INCLUDES

- A. Related Documents, Codes, and Sections
- B. Abbreviations, Acronyms and Definitions
- C. Project Drawings
- D. Quality Assurance
- E. Submittal Requirements
- F. Additional Requirements

#### 1.3 RELATED DOCUMENTS AND CODES

- A. Comply with the referenced codes and standards and with the Contract Documents. Where conflicts occur, the more stringent shall apply.

- B. The latest versions, including addenda, as enforced by the local authority having jurisdiction of the following codes, associations, acts and agencies:
1. Federal Communications Commission (FCC).
  2. National Fire Protection Association (NFPA), specifically:
    - a. NFPA 70, National Electrical Code® (NEC®)
    - b. NFPA 72, National Fire Alarm Code®
    - c. NFPA 76, Recommended Practice for the Fire Protection of Telecommunications Facilities
    - d. NFPA 101, Life Safety Code®
    - e. NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
    - f. NFPA 780, Standard for the Installation of Lightning Protection Systems
    - g. NFPA 5000™, Building Construction and Safety Code
  3. National Electrical Safety Code (NESC)
  4. Occupational Safety and Health Administration (OSHA)
- C. The following standards bodies:
1. American National Standards Institute (ANSI)
  2. National Electrical Manufacturers Association (NEMA)
  3. Telecommunications Industries Association (TIA), specifically:
    - a. TIA TSB-125, Guidelines for Maintaining Optical Fiber Polarity through Reverse-Pair Positioning
    - b. TIA TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems
    - c. TIA-526-7, Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant – OFSTP-7
    - d. ANSI/TIA-568-C.2-2009, Balanced Twisted-Pair Telecommunications Cabling and Component Standard
    - e. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard
    - f. ANSI/TIA-568.0-D-2015, Generic Telecommunications Cabling for Customer Premises
    - g. ANSI/TIA-568.1-D-2015 Commercial Building Telecommunications Infrastructure Standard
    - h. ANSI/TIA-569-D-2015, Telecommunications Pathways and Spaces
    - i. ANSI/TIA-598-C, Optical Fiber Cable Color Coding
    - j. ANSI/TIA-604.2-A, FOCIS 2—Fiber Optic Connector Intermateability Standard
    - k. ANSI/TIA-606, Administration Standard for Commercial Telecommunications Infrastructures
    - l. ANSI/TIA/607-C, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
    - m. ANSI/TIA-758-A, Customer-owned Outside Plant Telecommunications Infrastructure Standard

- n. ANSI/TIA-854-A, Full Duplex Ethernet Specification for 1000 Mb/s (1000BASE-TX) Operating over Category 6 Balanced Twisted-Pair Cabling
  - o. ANSI/NECA/*BicSI*® 568-2006, Standard for Installing Telecommunications Systems
4. Other Reference Materials
- a. ANSI/NECA/GICSI-568-2006, Standard, Installing Commercial Building Telecommunications Cabling
  - b. *BicSI*® Outside Plant Design Reference Manual (COOSP)
  - c. *BicSI*® Electronic Safety and Security Reference Manual (ESSDRM)
  - d. *BicSI*® Information Transport Systems Installation Methods Manual (ITSIM)
  - e. *BicSI*® Network Design Reference Manual (NDRM)
  - f. *BicSI*® Telecommunications Distribution Methods Manual (TDMM)
  - g. *BicSI*® Wireless Design Reference Manual (WDRM)
  - h. Institute of Electrical and Electronic Engineers (IEEE)
  - i. National Electrical Manufacturers Association (NEMA)
  - j. Underwriters Laboratories (UL®) Cable Certification and Follow up Program
  - k. American Standards Association (ASA)

#### 1.4 RELATED SECTIONS

- A. Section 270000 - Communications
- B. Section 270528 – Pathways for Communications Systems
- C. Section 270528.29 - Hangers and Supports for Communications Systems
- D. Section 270553 – Identification for Communication Systems
- E. Section 271513 – Communications Copper Horizontal Cabling
- F. Section 274100 – Audio-Video Systems
- G. Section 274123 – Audio-Video Accessories
- H. Section 275113 – Paging Systems
- I. Section 275313 – Clock Systems

#### 1.5 ABBREVIATIONS AND ACRONYMS

- A. AFF: Above Finished Floor
- B. AWG: American Wire Gauge
- C. *BicSI*®: Formerly known as “Building Industry Consulting Services International”

- D. CAT6: Category 6 Copper Cable
- E. CAT6A: Category 6A Copper Cable
- F. CMGC: Construction Manager/General Contractor
- G. CMP: Communications Multipurpose Plenum: cable rating
- H. CMR: Communications Multipurpose Riser: cable rating
- I. DAS: Distributed Antenna System
- J. ELFEXT: Equal-Level Far-End Crosstalk
- K. Gbps: Gigabits per second
- L. HVAC: Heating, Ventilation, and Air Conditioning
- M. Mbps: Megabits per second
- N. MMF: Multi-mode fiber optic cable, 50/125µm laser optimized core
- O. NEXT: Near End Cross Talk
- P. OSHA: Occupational Safety and Health Act
- Q. PoE: Power over Ethernet
- R. SCS: Structured Cabling System
- S. SFF: Small Form Factor
- T. TE: Telecommunications Enclosure
- U. TIA: Telecommunications Industry Association
- V. TR: Telecommunications Room
- W. UL®: Underwriters Laboratory
- X. UPS: Uninterruptible Power Supply
- Y. WAO: Work Area Outlet
- Z. WAN: Wide Area Network

## 1.6 DEFINITIONS

- A. Advanced System Warranty: An extended warranty held either by the connectivity or cabling manufacturer directly with the Owner for this project that guarantees product and performance of the entire cabling system for the warranty period.
- B. Building Backbone Cabling: Building backbone cabling carries aggregate traffic and, as such, impacts multiple network devices and users. Building backbone cabling includes fiber optic and copper cabling.
- C. Category 6: A category of transmission performance that specifies electrical properties up to 250 MHz. Refer to ANSI/TIA/568 family of standards for more information on Category 6 and ISO/IEC 11801 for more information on Class E requirements.
- D. Category 6A: A category of transmission performance that specifies electrical properties up to 500 MHz and capable of supporting data applications operating at 10Gbps. Refer to ANSI/TIA/568 family of standards for more information on Category 6.
- E. Certification: The testing and documentation of the transmission performance of a permanent link or channel, based on sweep frequency testing of numerous parameters with results compared to a range of acceptable values. This project requires 100% certification of all permanent link cabling.
- F. Conduit: A raceway of circular cross-section.
- G. Conveniently Accessible: Being capable of being reached from floor or use of 8' step ladder without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.
- H. Distributed Antenna System: A network of antenna nodes connected to common source(s) that provides wireless service.
- I. Equipment Room: An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate crossconnect, as well as video surveillance and security equipment.
- J. Horizontal Cabling: Cabling used to connect individual work area outlets to local Floor Distributors (FD) or other collection points. Unlike backbone cabling, horizontal cabling does not typically carry aggregate traffic and, as such, impacts only single network devices or users. In buildings, horizontal cabling almost exclusively consists of copper cabling. Fiber optic cabling may be used where situations dictate but, unlike horizontal copper cabling, horizontal fiber optic cabling is not installed in advance as default building facilities.
- K. Lead Telecommunications Installer: The project manager for the Telecommunications Subcontractor for all telecommunications work in the construction document Drawings and specifications, who shall be on-site at all times while Division 27 work is being performed. This individual shall attend all construction project meetings.

- L. Listed Communications Cable: A cable listed by the Underwriters Laboratory (UL®) and accepted by the local authority having jurisdiction as having met appropriate designated standards or has been tested and found suitable for installation in specific spaces. Refer to *NEC*® Article 800 for listing types and additional requirements.
- M. MDF: Main Distribution Frame, also known as the Main Equipment Room.
- N. Permanent Link – A stationary cabling segment, consisting of the permanently installed cable and the permanently affixed jack at both ends (typically at the outlet faceplate and closet patch panel, or on a patch panel on both ends). The concept is based on the assumption that, while patch cords might be disconnected or moved over time, the permanent cable and jacks will not be disturbed and the electrical characteristics of the permanent link will remain unaltered.
- O. Owner: Beaverton School District.
- P. Owner's Representative: An entity assigned to represent the Owner in all matters pertaining to this project. Used synonymously with "Owner".
- Q. Plenum: A space within the building designed for the movement of environmental air; i.e., a space above a suspended ceiling or below an access floor.
- R. Plenum-: Listed by the Underwriters Laboratory as being suitable for installation into a plenum space. Communications cabling routed through plenum-rated space shall be plenum-rated and identified as Type CMP.
- S. Point of Entrance (Building Entrance): The point within a building at which the Outside Plant (OSP) communications wire or cable emerges from an external wall, from a concrete floor slab, or from a rigid metal conduit (Type RMC) or an intermediate metal conduit (Type IMC) connected by a grounding conductor to an electrode in accordance with the *NEC*®.
- T. Raceway: Any channel designed for holding wires or cables; i.e. conduit, electrical metal tubing, busways, wireways, ventilated flexible cableway.
- U. Subcontractor, Telecommunications: Entity responsible for all telecommunications work in the construction documents (Drawings and specification Sections 270000 through 275319).
- V. Telecommunications: In general, telecommunications refers to infrastructure/equipment needed for the voice, data, and video communications and transport systems.
- W. Telecommunications Room/Space: An environmentally enclosed architectural space designed to contain telecommunications equipment, cable terminations, or crossconnect cabling. The Main Equipment Room may also be known as the MDF, and may be co-located with the building's Entrance Room and Equipment Room. Telecommunications Rooms will also house equipment for additional systems, such as security, cable television, and audio/video.

## 1.7 PROJECT DRAWINGS

- A. General Drawing Specifications: Detail and elevation Drawings shall be D size (24" x 36") with a minimum scale of 1/4" = 1'0" or larger. ER, TR and other enlarged detail floor plan Drawings shall be D size (24" x 36") with a minimum scale of 1/4" = 1'0" or larger. Building composite floor plan Drawings shall be D size (24" x 36") with a minimum scale of 1/8" = 1' 0".
- B. Building composite floor plans: Provide building floor plans showing outlet locations and jack configuration, types of jacks, run distance for each jack cable, and cable routing/locations. Identify WAO's that, according to location and available pathway systems, require cable length greater than allowed by standards. Recommend alternatives for Owners Representative's consideration.
- C. Telecommunications space plans/elevations: Include enlarged floor plans of TRs indicating layout of equipment and devices, including receptacles and grounding provisions. Submit detailed plan views and elevations of telecommunications spaces showing racks, termination blocks, and cable paths.
- D. Logical Drawings: Provide logical riser or schematic Drawings for all systems. Include schematic symbol key.

## 1.8 QUALITY ASSURANCE

### A. Telecommunications Subcontractor Qualifications

#### 1. Company Requirements

- a. The Telecommunications Subcontractor shall have total responsibility for the coordination and installation of the work shown and described in the Drawings and Specifications.
- b. Telecommunications Systems specified shall be assembled and installed under the direction of a qualified Telecommunications Subcontractor. Qualification requirements shall include submittal by the Telecommunications Subcontractor to the Architect of the following:
  - 1) List of previous projects of this scope and nature, including names and sizes of projects (to include square footage and construction cost – overall and that of the Telecommunications Subcontractor), description of work, times of completion, and names of contact persons for reference.
  - 2) Installers shall certify that they are manufacturer-authorized or trained for work to be performed.

#### 2. Lead Telecommunications Installer Requirements:

- a. Lead Communications Installer shall be a current member of *Bicsi*® in good standing and have completed (at a minimum) *Bicsi*® ITS Installer 2 Training (for both copper and fiber).

- b. Submit certificate of ITS Installer 2 Training (or higher) with bid and preconstruction submittal package.
    - c. Advanced training from connectivity manufacturer may be submitted in lieu of *Bicsi*® ITS Installer 2 Training. Submit manufacturer training certificates for review by Owner as substitution request as part of Pre- Bid questions. This training must be by the same manufacturer that will hold the Advanced System Warranty.
  - 3. General Telecommunications Installer Requirements:
    - a. For all work associated with Specification Sections 27 all installers are to have a minimum of *Bicsi*® ITS Installer 1 Training or equivalent training from the connectivity manufacturer.
    - b. Submit a list with bid of names of all installers and appropriate copies of certificates verifying training with pre-construction submittal package.
  - B. When articles, materials, operations or methods related to execution of communications work are noted, specified, or described in the specifications or are indicated or reasonably implied on Drawings and schedules, execute work as required or appropriate to provide complete and proper function, operation and installation.
  - C. The Drawings utilize symbols and schematic diagrams to indicate items of work. These symbols and diagrams will not typically identify dimensions nor will they identify inclusion of specific accessories, appurtenances and related items necessary and appropriate for a complete and proper installation and operation. The Telecommunications Subcontractor shall install work complete and ready for proper operation, including related items not specifically identified, shown, indicated or specified. The work shall be installed, in accordance with the intent diagrammatically expressed on the Drawings, and in conformity with the dimensions indicated on architectural Drawings and on shop Drawings approved by the Owner.
  - D. The Drawings include details for various items, which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility; they do not obviate field coordination for the indicated work. Work shall not proceed until actual field conditions and requirements are verified by the Telecommunications Subcontractor.
  - E. The Drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions.
- 1.9 WARRANTY
- A. Warranty Requirements: Comply with additional requirements in contract general requirements and extended warranties required in other specification sections. Refer to all other 27 sections for specific additional warranty requirements that exceed or are in addition to those of this section.

B. Contractor Warranty: Provide all services, materials and equipment necessary for successful operation of entire SCS system for a period of one year after system acceptance. Scope of warranty includes all equipment, devices, wiring, accessories, software, hardware, installation, and configuration required to maintain a complete and operable system. This shall apply to all items except those specifically excluded, or items wherein a longer period of service and warranty is specified or indicated. All warranties shall be effective for one year, minimum, from date Certificate of Final Acceptance is issued. Use of systems provided under this section for temporary services and facilities shall not constitute final acceptance of work nor beneficial use by Owner and shall not institute warranty period.

1. The warranty shall cover repair or replacement of defective materials, equipment, workmanship, and installation that may be incurred during this period. Warranty work is to be done promptly and to Owner's satisfaction. In addition, warranty shall cover correction of damage caused in making necessary repairs and replacements under warranty.

C. Project Warranty

1. Equipment and materials required for installation under these specifications shall be the current model and new (less than one year from date of manufacture), unused and without blemish or defect, and are to be guaranteed to be free from defect.
2. When a defect or problem is observed within the first year after substantial completion, the Owner will notify the governing subcontractor through the proper channels. The appropriate Subcontractor then has 48 hours to fix the defect or furnish and install a replacement part/system, all at no cost to the project or Owner.

D. Advanced System Warranty for Telecommunications (Copper and Fiber Systems)

1. Beyond the initial one year project warranty, the Telecommunications Systems shall be warranted for a minimum of 20 years by a national and reputable connectivity or cabling manufacturer.
  - a. This warranty shall cover any material defect, as well as the performance of the cabling system. (Example: A Category 6A cabling system is to deliver 10,000BASE-T speed, or 10 "Gig" performance for the entire length of the warranty period.)
  - b. This warranty shall cover material and labor for the entire warranty period.
2. The Telecommunications Subcontract shall be certified by this manufacturer.
3. The following manufacturers are conditionally approved to provide the system warranties (subject to specific project requirements):
  - a. Copper Connectivity Manufacturers
    - 1) CommScope (Systimax®, Uniprise®)
    - 2) Panduit
  - b. Fiber Connectivity Manufacturers

- 1) CommScope (Systimax®, Uniprise®)
- 2) Panduit

c. Cabling Manufacturers

- 1) CommScope (Systimax®, Uniprise®)
- 2) General (for Panduit product set)

- E. Owner's rights: This section shall not be interpreted to limit Owner's rights under applicable codes and under this Contract.

## 1.10 SUBSTITUTIONS

- A. Substitution requests: Substitution requests will be considered only if submitted to Owner's Representative not less than 7 working days prior to project bid date. Acceptance or rejection of proposed substitution is at Owner's Representatives sole discretion. No exceptions. Requests for substitutions shall be considered not approved unless approval is issued in writing by Owner's Representative.
- B. Rejection: For equipment, cabling, wiring, materials, and all other products indicated or specified as no substitutions or no alternates, Owner does not expect nor desire requests for substitutions and alternate products other than those specified. Owner reserves right for Owner's Representative to reject proposed substitution requests and submissions of alternates without review or justification.

## 1.11 SUBMITTALS

A. General Requirements

1. Owner is to review all submittals related to Division 27 work. This includes, but is not limited to, relevant:
  - a. Pre-bid questions.
  - b. Contractor and personnel qualifications with bid.
  - c. Voluntary alternates and unit pricings with bid.
  - d. Pre-construction product submittals and shop Drawings.
  - e. Change order requests, requests for information (RFIs), design change directives (DCDs), and any other changes as directed by the architect/engineer.
2. Allow a minimum of one week (five working days) for the Owner to review.

B. The following submittals are due at the Pre-Bid deadline for questions:

1. Requests for product substitution shall be in accordance with this document.
2. All products seeking approval either as "approved equivalent" or otherwise, shall be submitted as a product substitution request prior to bid. Failure to submit product

substitution request in a timely manner (before pre-bid questions are due) may preclude product from being utilized on the project. Requests made with bid or post-bid will not be considered without a significant cost savings realized to the Owner.

3. The burden of proof is on the contractor to provide documentation that equivalent product meets the specifications and project requirements. Include in substitution request:
  - a. Product being replaced.
  - b. Reason for product substitution.
  - c. Full manufacturer specification sheet clearly indicating that all requirements in project documents have been met.
4. Failure to meet these requirements will result in the product substitution request being returned without review.
5. All product substitution requests are to be reviewed and approved by the Owner. Not all requests will be approved, and all decisions are final, without recourse.

C. The following submittals are due with the Bid:

1. Proof of Telecommunications Subcontractor and personnel qualifications
  - a. Provide a typed list with the following information:
    - 1) Company name of Telecommunications Subcontractor.
    - 2) List of connectivity or cabling manufacturers that the Telecommunications Subcontractor is certified to install and provide advanced warranty for.
    - 3) List of previous projects (minimum of 3) of this scope and nature, including:
      - a) Project name and date of completion.
      - b) Project size (square feet of building, total construction cost, total cost of telecommunications scope).
      - c) Name and contact information for building owner or IT Manager.
      - d) Name and contact information for Lead Telecommunications Installer.
      - e) Provide certificates or letter(s) from *Bicsi*® and / or manufacturers verifying by name these qualifications have been met.
      - f) Refer to Quality Assurance subsection in this specification section for additional requirements and qualifications.
2. Voluntary alternatives (that realize substantial cost savings).
3. Unit pricing for the following items:
  - a. All unit pricing relating to Division 27 as identified in these documents and accompanying T series Drawings.

D. The following submittals are due at the Pre-Construction Phase (to be delivered to the Owner):

1. General Requirements:
  - a. Follow submission guidelines as outlined in this section.
    - 1) Strictly electronic submission to Owner is acceptable.
  - b. Ensure a cover page with Project Title, Telecommunication Subcontractor Company, and point of contact is included for all physical submittals.
  - c. Updated Personnel Qualifications.
    - 1) Provide a list of names of all telecommunications installers with appropriate certificates from *Bicsi*® or the manufacturer.
2. Product Information, divided by Specification Section and in order as listed in specification. Identify the start of each specification section.
  - a. Provide manufacturer's product information cutsheet or specifications sheet with the specific product number identified or filled out.
    - 1) Submitted cutsheets without specific product identified will result in the whole submittal being returned without review.
    - 2) No product substitutions will be considered post bid without a significant cost savings to the project to be realized by the owner – a minimum of \$1000, either in material or labor savings. For any product substitution requests post-bid, Telecommunications Subcontractor shall submit an RFI through the proper channels with the requested documentation from the Pre-bid requirements above. Also, include realized cost savings. The project team may issue a change order (or its equivalent) for the product change at their discretion.
      - a) One exception to this is if the specified product goes out of production and is unavailable before submitted shop Drawings are approved. Telecommunications or Subcontractor is to submit an RFI explaining the situation and recommending an equivalent product with the same features at no cost change to the project or Owner.
      - b) Other exceptions may be considered. Telecommunications Subcontractor is to submit an RFI explaining the situation.
3. Shop Drawings
  - a. Generate electronic shop Drawings in AutoCAD®, dwg file format, version 2004 (or newer), saved to disk (CD-R or DVD+/-R) or USB Flash Drive with project name and number clearly indicated or uploaded to project website. Shop Drawings shall include Telecommunications or Subcontractor title block and included readily printable Plot/Drawing tabs with mview-window at a scale to not be less than 1/8" = 1'-0" unless otherwise noted. The scale shall also be indicated on the Drawings.

- b. Acceptable electronic shop drawing sizes include:
    - 1) 8.5"x11"
    - 2) 11"x17"
    - 3) 22"x34"
    - 4) 24"x36"
  - c. Refer to individual sections for additional requirements.
  - d. Communications pathways.
    - 1) Hangers and Supports – indicate proposed routing of all cabling supported by J-hooks.
    - 2) Cable Trays - indicate size and proposed routing of all communications cable trays; should any of those locations or sizes differ from the construction Drawings due to minor coordination issues, cloud the affected area and note why the change is necessary. (For major coordination issues, please submit an RFI.)
    - 3) Firestopping – indicate manufacturer, product/assembly, and UL system for all firestop penetrations required for communications cabling.
- E. The following submittals are due during Construction (project closeout), in accordance with the requirements of this Section 270000 - Communications:
- 1. 3 weeks prior to Substantial Completion:
    - a. Record Drawings.
      - 1) Modify reviewed and accepted AutoCAD® shop Drawings to include revisions based upon completion of work.
      - 2) Provide one printed set of record Drawings to scale (not less than 1/8" = 1'-0").
      - 3) This set is to include system function diagrams and details not on original construction documents.
    - b. With the exception of the (1) printed set of record Drawings, submit these files electronically either on disk (CD or DVD) or USB Flash Drive, with project name and number clearly indicated.
  - 2. Within two weeks after Substantial Completion:
    - a. Warranty Certificates for the Advanced Telecommunications System Warranty for the copper and fiber systems with point of contact for any warranty claims.

## 1.12 ADDITIONAL REQUIREMENTS

- A. Integration: Responsibility for overall telecommunications system integration and coordination of work among trades, subcontractors, and suppliers shall rest with Contractor named in this contract. Work covered by this division of specifications shall be coordinated with related work indicated on Drawings or specified elsewhere under project specifications. All work related to telecommunications system and required for complete and operational systems as detailed in these specifications or the accompanying T series Drawings shall be performed under direct supervision of telecommunications system installer in a manner approved by product manufacturer.
- B. Coordination of work: Contractor shall be responsible for coordination of work among project specification divisions and contractor/subcontractors involved in this project. This coordination of work includes following instructions provided throughout all Division 27 specifications and the accompanying T series Drawings as well as electrical work (normally addressed in Division 26) as called out in the narrative portions of Division 27 or so referenced in the accompanying T series Drawings.
- C. General compliance requirements: Provide a complete and operable system in compliance with project Drawings, specifications, referenced standards, applicable building codes, and Authority Having Jurisdiction (AHJ) requirements. Scope of this contract includes planning, design, materials, equipment, labor, configuration, programming, testing, startup and commissioning services, and documentation costs for complete and operable system that meets all requirements indicated on Drawings or contained in specifications. Comply with all contract documents, specifications, Drawings, manufacturer's instructions, and Owner and AHJ requirements. In case of conflict among applicable documents or standards, contractor shall notify owner's representative in writing of apparent conflict, and then comply with most stringent requirements unless otherwise directed in writing from owner's representative.

## 1.13 DELIVERY STORAGE AND HANDLING

- A. General: Owner will, at Contractor's request, provide appropriate space on site for Contractor trailer or job box; however, Contractor shall be responsible for the deliveries, storing and handling of all materials relative to the SCS systems, including materials supplied by others that are part of the SCS installation contract. Material shall be stored and protected according to manufacturer's instructions. Contractor shall be responsible for the security of all material during installation. For all material provided by contractor, or delivered to contractor on site, contractor assumes full responsibility and liability for any material shortages, damage or loss due to storage and handling methods.

## 1.14 PERMITS AND INSPECTIONS

- A. General: All telecommunications systems shall meet or exceed the latest requirements of all national, state, county, municipal, and other authorities exercising jurisdiction over the telecommunications systems and the Project.

- B. Contractor shall obtain and pay for all licenses, permits, and inspection fees required by local agencies and/or other agencies having jurisdiction. Copies of all permits shall be delivered electronically to the Owner.
- C. Contractor agrees to furnish any additional labor or material required to comply with all local and other agencies having jurisdiction at no additional cost.
- D. Contractor shall obtain certificates of inspection and approval from all authorities having jurisdiction, and forward copies of same to Owner prior to request for Project acceptance inspections, final completion inspections, substantial completion inspections, and acceptance testing/demonstrations.
- E. All required permits and inspection certificates shall be made available at the completion of the telecommunications system installation and commissioning.
- F. Any portion of the telecommunications work which is not subject to the requirements of an electric code published by a specific AHJ shall be governed by the National Electrical Code and other applicable sections of the National Fire Code, as published by the National Fire Protection Association (NFPA).
- G. Installation procedures, methods and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Administration (OSHA).
- H. All work shall comply with the TIA Standards listed in this document.

#### 1.15 EXAMINATION

- A. General: Prior to submitting a proposal, Contractor shall examine site, review Project Drawings and specifications, and determine exact extent of work required. Contractor shall include in their proposals all materials, labor, and equipment required to complete required work indicated. Work that is necessary to obtain complete and usable Project as specified herein shall be included in Contractor's proposal, even if not indicated or specified.
- B. Bidders' questions: Should bidders have questions as to intent of Drawings and specifications, quality of materials to be used, and work to be performed, questions shall be submitted in writing to the Owner in manner dictated by the Owner. All answers and clarifications to Drawings and specifications will be issued in writing.
- C. Extra payment will not be allowed for claims for due to unfamiliarity with work to be performed by other trades, existing conditions at job site, local or state laws and codes, and alterations due to field conditions.

#### 1.16 ADDITIONAL COSTS

- A. General: Project acceptance inspections, final completion inspections, substantial completion inspections, and acceptance testing/demonstrations shall be conducted after verification of

system operation and completeness by Contractor.

- B. Inspections and testing: For Project acceptance inspections, final completion inspections, substantial completion inspections, and/or testing/demonstrations that require more than one site visit by Owner or Architect/Engineer to verify Project compliance for same material or equipment, Owner reserves right to obtain compensation from Contractor to defray cost of additional site visits that result from Project construction or testing deficiencies/incompleteness, incorrect information, or non-compliance with Project provisions. Owner will notify Contractor of hourly rates and travel expenses for additional site visits, and will issue an invoice to Contractor for additional site visits. Payment of additional site visit costs by Contractor is required within 30 days of invoicing. Owner reserves right to deduct additional costs defined herein that are indicated on past due invoices from Project amount due Contractor.
- C. Exclusions: Contractor shall not be eligible for extensions of Project schedule or additional charges resulting from additional site visits that result from Project construction or testing deficiencies/incompleteness, incorrect information, or non-compliance with Project provisions.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.
- B. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer and part number.
- C. All products and materials shall be new and unused prior to their installation as part of this project. Refurbished items are not allowed.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Coordinate with all other trades prior to installation.
  - 1. Telecommunications Subcontractor shall meet with Electrical, Mechanical, and General Contractors prior to construction to identify pathway and infrastructure space requirements.
    - a. At a minimum, the following items shall be discussed:
      - 1) Cable tray locations and clearance space above (12" if possible, with proper coordination).
      - 2) Placement for sleeving and wall penetrations.

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- 3) In-ceiling projection screens and other audio/video equipment.
  - b. Failure to coordinate sufficient space for telecommunications infrastructure shall result in relocation of various systems by the contractor at no additional cost to owner.
2. Prior to the start of work, the Telecommunications Subcontractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where Division 27 work may properly commence. Start of work indicates acceptance of conditions.
3. Coordinate location of equipment and conduit with other trades to minimize interference.
  - a. Holes through concrete and masonry structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the base building.
  - b. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by the General Contractor as required by limited working space.
  - c. Holes shall be located so as not to affect structural sections such as ribs or beams.
  - d. Holes shall be laid out in advance. The General Contractor shall be advised prior to drilling through structural sections, for determination of proper layout.
  - e. Structural Penetrations: Where conduits, wireways and other raceways pass through fire partitions, fire walls or walls and floors, provide an effective barrier against the spread of fire, smoke and gases.
- B. Follow all manufacturers' instructions and install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.
  1. In the event of discrepancy, immediately notify the Owner through the proper channels. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.
- C. Protection of Systems and Equipment
  1. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.
  2. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on sides with securely fastened protective rigid or flexible waterproof coverings.
  3. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum-cleaned both inside (as appropriate) and outside before testing, operating or painting.
- D. As determined by the Owner, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Owner shall be final.

- E. Painted surfaces shall be protected with removable heavy kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.
- F. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer.
- G. Access to Equipment
  - 1. Equipment shall be installed as per the scaled detail on the Power & Signal Drawings.
  - 2. Working spaces shall be not less than specified in the National Electrical Code® for voltages specified.
  - 3. Where the Owner determines that the Telecommunications Subcontractor has installed equipment not “conveniently accessible” for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the Owner, at no additional cost to the Owner.
- H. Cleaning
  - 1. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by communications work.
  - 2. Remove dust and debris from interiors and exteriors of telecommunications equipment (including electrical rough-in). Clean accessible current carrying elements prior to being energized.
- I. Completion
  - 1. General:
    - a. Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.
  - 2. Results Expected:
    - a. Systems shall be complete and operational.
    - b. Cleaning work shall be complete.
  - 3. Testing and Verification – General Requirements.
    - a. Refer to individual sections for additional testing and verification requirements.
    - b. The Telecommunications Subcontractor shall verify that requirements of this specification are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.
    - c. Verification by Inspection: Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the specifications.

- d. Verification by Test and Demonstration: The Telecommunications Subcontractor shall verify by formal demonstrations or tests that the requirements of this Specification have been met. The Communications Subcontractor shall demonstrate that the communications systems components and subsystems meet specification requirements in the "as-installed" operating environment during the "System Operation Test".
- e. Perform system operation tests after full enclosure of walls.
- f. System Operation Tests Conducted Upon Completion of Work: Upon completion of the Telecommunications Subcontractor's Work, subject the system to functional and operational tests. When required corrections determined by initial test results have been completed, fully retest the system. The Owner shall be notified in writing not less than seven days in advance of date of proposed final testing and inspection. The advance notice shall include certification that the installation is complete and operable and that the Telecommunications Subcontractor has satisfactorily performed the final tests specified herein.
- g. The acceptance testing and final inspection shall be accomplished in the presence of the Owner. At least 10 days prior to scheduled system completion, the Telecommunications Subcontractor shall submit, for approval by Owner, a test plan to completely test the telecommunications system. The Telecommunications Subcontractor shall include in test plan, for acceptance by the Owner, a complete and detailed final acceptance test check-off list ("punch list"). The list shall be a complete representation of specified functions and conditions.

4. Commissioning

- a. There shall be three phases of commissioning:
  - 1) Rough-in inspection.
  - 2) Above-ceiling inspection (after cables are placed).
  - 3) Final inspection.
- b. At a minimum, the Owner shall check the following items:
  - 1) Accurate location and height AFF for all outlet boxes.
  - 2) Accurate dimensions (particularly depth) of all outlet boxes and diameter of in-wall conduit serving outlet boxes.
  - 3) Cable tray size, location, and clearance.
  - 4) Location and size of communications conduits or pathways.
  - 5) That power receptacles within the communications rooms meet the design requirements.
  - 6) The Owner is then to issue a written report to the General Contractor identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate subcontractor(s) and all items are to be addressed.
  - 7) This report is not necessarily all inclusive; should issues be discovered later in the project, the appropriate communications subcontractor is still responsible for corrections/repairs.

- c. Once all communication cabling has been installed and properly supported and walls have been painted, but prior to the installation of ceiling tiles/material, the Owner shall schedule a time to be on-site to conduct above-ceiling inspection. At a minimum, the Owner shall check the following items:
  - 1) That all items from the previous inspection have been corrected.
  - 2) That communications cabling is routed correctly and adequately supported.
  - 3) That communications cabling is not painted or over sprayed.
  - 4) That the installed communications cabling matches what was specified / submitted.
  - 5) That there are no kinks, splices, or other damage to the installed communications cabling.
- d. The Owner is then to issue a written report to the General Contractor identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate subcontractor(s) and all items are to be addressed. This report is not necessarily all inclusive; should issues be discovered later in the project, the appropriate communications subcontractor is still responsible for corrections/repairs.
- e. Once all communications work has been completed, contractor shall request final inspection. This request shall be made 3 weeks before substantial completion. The Owner shall then schedule a time to be on-site to conduct this inspection. At a minimum, the Owner shall check the following items:
  - 1) That all items from the previous inspections have been corrected.
  - 2) That all faceplates are installed, with the correct modules, quantity of modules, and approved labeling scheme.
  - 3) That all equipment and cabling within communications rooms is installed per the contract documents, including all patch panels and wall blocks (with specified spare capacity), horizontal and backbone cabling labeling, and telecommunications grounding.
  - 4) And all other items necessary to guarantee contract documents are met and complete and functioning communications systems are installed.
- f. The Owner is then to issue a written report to the General Contractor identifying all items which currently do not meet the construction document requirements. This report is to be forwarded to the appropriate subcontractor(s) and all items are to be addressed prior to substantial completion. This report is not necessarily all-inclusive; should issues be discovered within one year after substantial completion, the appropriate communications subcontractor is still responsible for corrections/repairs.

END OF SECTION 270000

## SECTION 270500 - COMMON WORK RESULTS FOR COMMUNICATIONS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. General Requirements
- B. Summary
- C. Environmental Considerations
- D. Site Specific Requirements

#### 1.2 RELATED SECTIONS

- A. Section 270000 - Communications
- B. Section 270528 – Pathways for Communications Systems
- C. Section 270528.29 – Hangers and Supports for Communications Systems
- D. Section 270553 – Identification for Communication Systems
- E. Section 271513 – Communications Copper Horizontal Cabling
- F. Section 274100 – Audio-Video Systems
- G. Section 274123 – Audio-Video Accessories
- H. Section 275113 – Paging Systems
- I. Section 275313 – Clock Systems

#### 1.3 SPECIFIC REQUIREMENTS

- A. Beaverton School District is a tobacco free environment. Tobacco in any form whatsoever is not permitted in this school or on the property owned by the District.
- B. Beaverton School District is constructing an addition to the existing school as per the accompanying drawings. This contract will be responsible for all aspects of telecommunications cabling and supporting infrastructure required for functional systems.

#### 1.4 SUMMARY

- A. The intent of the Division 27 Specifications and the accompanying Drawings is to provide a complete and workable system as shown, specified and required by applicable codes and the Authority Having Jurisdiction (AHJ). Include all work as specified in Division 27 and shown on the accompanying Drawings, including appurtenances, to provide a complete and functional system.
- B. The Division 27 Specifications and accompanying Drawings are complementary and what is called for in one shall be as binding as if called for in both. Items shown on the Drawings are not necessarily included in or called out in the Specifications and vice versa. Specifications shall supersede Drawings in the case of a conflict.
- C. Imperative language is frequently used in the Division 27 Specifications. Except as otherwise noted, such requirements are to be performed by the Contractor or a Sub-contractor directly responsible to the Prime Contractor performing the Division 27 work.
- D. The Drawings accompanying Division 27 are diagrammatic. They do not show every component of a complete premises distribution system which may be required to accommodate unique building construction features or materials installed by other trades. The Drawings are to be followed as closely as practical while making necessary adjustments in the placement of cable to facilitate the overall construction of the building without additional cost to the Owner. The right is reserved to make any reasonable changes in Work Area Outlet locations prior to roughing-in.

#### 1.5 ENVIRONMENTAL CONSIDERATION

- A. When at all possible, equipment and materials are to be assembled at Distributors or Contractors location and delivered to construction site without packaging or shipping material.
- B. Except as noted for purposes of recycling, all construction related debris; packaging and waste materials will be removed from the job site each day and disposed of by the Contractor.

#### 1.6 SITE SPECIFIC REQUIREMENTS

- A. Contractor must conform to schedule prescribed by General Contractor.
- B. Site details are shown on the accompanying drawings.

#### 1.7 DEVICE LOCATIONS

- A. Cabling, pathway, fire stopping, and support structures as per the Drawings and specifications.
- B. Work Area Outlets (WAO) will be as per the Drawings. Owner reserves the right to make slight modifications in placement of the WAO prior to cover.

SATO ES ADDITION  
BEAVERTON SCHOOL DISTRICT  
PORTLAND, OREGON

74-22109-00  
10 JUNE 2022  
BID / PERMIT SET

PART 2- (NOT USED)

PART 3 - (NOT USED)

END OF SECTION 270500

COMMON WORK RESULTS FOR COMMUNICATIONS

270500 - 3

## SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Hooks.
7. Boxes, enclosures, and cabinets.
8. Polymer-concrete handholes and boxes for exterior underground cabling.
9. Fiberglass handholes and boxes for exterior underground cabling.

#### 1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid conduit.
- C. IMC: Intermediate metal conduit.
- D. RTRC: Reinforced thermosetting resin conduit.

#### 1.4 ACTION SUBMITTALS

- A. Product data for the following:
  1. Wireways and fittings.
  2. Boxes, enclosures, and cabinets.
  3. Underground handholes and boxes.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway 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 pathway groups with common supports.
  - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
  - 3. Underground ducts, piping, and structures in location of underground enclosures and handholes.
- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Data: Provide seismic bracing for all pathway racks, enclosures, cabinets, equipment racks, and their mounting provisions, including those for internal components, from manufacturer.
  - 1. Confirm building occupancy category and seismic design category and provide stamped shop drawings from licensed structural engineer of seismic bracing and seismic movement assemblies for cabinets, racks and major equipment. Submit with shop drawings.
  - 2. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 4. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
  - 5. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.
- D. Source quality-control reports.

## PART 2 - PRODUCTS

### 2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AFC Cable Systems; a part of Atkore International.
  - 2. Allied Tube & Conduit; a part of Atkore International.
  - 3. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 4. Republic Conduit.
  - 5. Thomas & Betts Corporation; A Member of the ABB Group.

## PATHWAYS FOR COMMUNICATIONS SYSTEMS

270528 - 2

6. Western Tube and Conduit Corporation.

C. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-D.

D. GRC: Comply with ANSI C80.1 and UL 6.

E. ARC: Comply with ANSI C80.5 and UL 6A.

F. IMC: Comply with ANSI C80.6 and UL 1242.

G. PVC-Coated Steel Conduit: PVC-coated GRC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

H. EMT: Comply with ANSI C80.3 and UL 797.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Fittings for EMT:

- a. Material: Steel.
- b. Type: Set Screw.

2. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch with overlapping sleeves protecting threaded joints.

J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.

B. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.
3. Arnco Corporation.

4. CANTEX Inc.
5. CertainTeed Corp.
6. Condux International, Inc.
7. Electri-Flex Company.
8. Kraloy.
9. Lamson & Sessions; Carlon Electrical Products.
10. Niedax-Kleinhuis USA, Inc.
11. RACO; a Hubbell company.
12. Thomas & Betts Corporation.

C. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
  2. Comply with TIA-569-D.
- D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. Rigid HDPE: Comply with UL 651A.
- F. Continuous HDPE: Comply with UL 651A.
- G. RTRC: Comply with UL 2515A and NEMA TC 14.
- H. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.
- I. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum installation unless otherwise indicated.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Alpha Wire.
  2. Carlon; a brand of Thomas & Betts Corporation.
  3. Dura-Line.
  4. Endot Industries Inc.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.

## 2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. B-line, an Eaton business.
  - 2. Hoffman; a brand of Pentair Equipment Protection.
  - 3. MonoSystems, Inc.
- C. General Requirements for Metal Wireways and Auxiliary Gutters:
  - 1. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
  - 2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
  - 3. Comply with TIA-569-D.
- D. 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.
- E. Finish: Manufacturer's standard enamel finish.

## 2.5 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.
- B. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Allied Moulded Products, Inc.
  - 2. Carlon; a brand of Thomas & Betts Corporation.
  - 3. Hoffman; a brand of Pentair Equipment Protection.
- D. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:
  - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

2. Comply with TIA-569-D.

- E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- F. Solvents and Adhesives: As recommended by conduit manufacturer.

2.6 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. MonoSystems, Inc.
  - 2. Panduit Corp.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.
- E. Galvanized steel.
- F. J shape.

2.7 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Adalet.
  - 2. Cooper Technologies Company; Cooper Crouse-Hinds.
  - 3. FSR Inc.
  - 4. Hoffman; a Pentair company.
  - 5. Hubbell Incorporated; Killark Division.
  - 6. Mono-Systems, Inc.
  - 7. O-Z/Gedney; a brand of EGS Electrical Group.
  - 8. RACO; a Hubbell Company.
  - 9. Thomas & Betts Corporation.
  - 10. Wiremold / Legrand.
- C. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
  2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
  3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
  4. Device Box Dimensions: 4-11/16 inches square by 2-5/8 inches deep with a 5/8" single gang mud ring cover.
  5. Gangable boxes are prohibited.
- D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- F. Metal Floor Boxes:
1. See specification section 260533 for combined power and data floor box requirements.
- G. Nonmetallic Floor Boxes: Not Allowed.
- 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, cast aluminum with gasketed cover.
- J. Nonmetallic Outlet and Device Boxes: Not Allowed
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
    - a. Finished inside with radio-frequency-resistant paint.
  2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. Cabinets:
1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  2. Hinged door in front cover with flush latch and concealed hinge.
  3. Key latch to match panelboards.
  4. Metal barriers to separate wiring of different systems and voltage.
  5. Accessory feet where required for freestanding equipment.

## PART 3 - EXECUTION

### 3.1 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
  - 1. Exposed Conduit: GRC.
  - 2. Concealed Conduit, Aboveground: EMT.
  - 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
  - 4. Boxes and Enclosures, Aboveground: NEMA 250, NEMA-3R.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
  - 1. Exposed, Not Subject to Physical Damage: EMT.
  - 2. Exposed and Subject to Severe Physical Damage: GRC Pathway locations include the following:
    - a. None anticipated in current scope.
  - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  - 4. Damp or Wet Locations: GRC.
  - 5. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, EMT.
  - 6. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT.
  - 7. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: EMT.
  - 8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: 1-inch trade size for copper and aluminum cables, and 1-1/4 inch for optical-fiber cables.
- D. Pathway Fittings: Compatible with pathways 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 set-screw fittings. Comply with NEMA FB 2.10.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface pathways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

### 3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
  - 1. NECA 1.
  - 2. NECA/BICSI 568.
  - 3. TIA-569-D.
  - 4. NECA 101
  - 5. NECA 102.
  - 6. NECA 105.
  - 7. NECA 111.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements in Section 270528.29 "Hangers and Supports for Communications Systems" for hangers and supports.
- E. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- F. Complete pathway installation before starting conductor installation.
- G. All conduits to have bushings installed on ends prior to cable being pulled.
- H. In cases where EMT cannot be used, 1-1/4" flexible metallic conduit may be used.
- I. Provide conduit pathway in all inaccessible locations including walls, floors and ceilings.
- J. Provide conduit pathway where routed in exposed ceilings to structure.
- K. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- L. Install no more than the equivalent of two 90-degree bends in any pathway run. Provide pull boxes as needed to comply. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- M. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- N. Support conduit within 12 inches of enclosures to which attached.
- O. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
  2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
  3. Arrange pathways to keep a minimum of 2 inches 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 nonmetallic conduit and fittings to GRC fittings before rising above floor, continue with GRC to 3 to 6 inches above floor.
- P. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for pathways.
  2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
  3. Sleeves to protrude 3" to 6" above the surface of the floor.
- Q. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- R. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- S. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- T. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- U. 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.
- V. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- W. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- X. Surface Pathways:
1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
  2. Install surface pathway with a minimum 2-inch radius control at bend points.

3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- Y. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 1-1/4-Inch minimum trade size: Install pathways in maximum lengths of 75 feet.
  2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- Z. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, 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 pathway-sealing fittings according to NFPA 70.
- AA. Install devices to seal pathway 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 pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  2. Where an underground service pathway enters a building or structure.
  3. Where otherwise required by NFPA 70.
- BB. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- CC. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
  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 temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    - d. Attics: 135 deg F 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 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 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.

DD. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet o.c.
5. Provide a hook at each change in direction.

EE. Mount WAP 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.

FF. 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 surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

GG. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

HH. 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.

II. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

JJ. Set metal floor boxes level and flush with finished floor surface.

KK. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

### 3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or 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 270528

## SECTION 270528.29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Steel slotted support systems for communication raceways.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

#### 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 the following:
  - a. Slotted support systems, hardware, and accessories.
  - b. Clamps.
  - c. Hangers.
  - d. Sockets.
  - e. Eye nuts.
  - f. Fasteners.
  - g. Anchors.
  - h. Saddles.
  - i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

- B. Shop Drawings: For fabrication and installation details for communications hangers and support systems.

1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For hangers and supports for communications systems.

1. Include design calculations and details of trapeze hangers.
2. Include design calculations for seismic restraints.

#### 1.4 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. Suspended ceiling components.
2. Ductwork, piping, fittings, and supports.
3. Structural members to which hangers and supports will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:
  - a. Luminaires.
  - b. Air outlets and inlets.
  - c. Speakers.
  - d. Sprinklers.
  - e. Access panels.
  - f. Projectors.

B. Seismic Qualification Certificates: For hangers and supports for communications equipment and systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

#### 1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.
- B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified."
  2. Component Importance Factor: 1.0.

### 2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit; a part of Atkore International.
    - b. B-line, an Eaton business.
    - c. ERICO International Corporation.
    - d. GS Metals Corp.
    - e. Thomas & Betts Corporation; A Member of the ABB Group.
    - f. Unistrut; Part of Atkore International.
  2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  3. Material for Channel, Fittings, and Accessories: Galvanized steel.
  4. Channel Width: Selected for applicable load criteria.
  5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
  8. Channel Dimensions: Selected for applicable load criteria.

- B. Conduit and Cable Support Devices: Steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications 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 made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. 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 where used.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) B-line, an Eaton business.
      - 2) Empire Tool and Manufacturing Co., Inc.
      - 3) Hilti, Inc.
      - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
  - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
  - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
  - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  - 5. Toggle Bolts: All-steel springhead type.
  - 6. Hanger Rods: Threaded steel.

## 2.3 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

### 3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
  - 1. NECA 1.
  - 2. NECA/BICSI 568.
  - 3. TIA-569-D.
  - 4. NECA 101
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- E. 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.

### 3.2 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, according to NFPA 70.
- 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.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications 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: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Existing Concrete: Use expansion anchor fasteners.
  5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
  6. To Light Steel: Sheet metal screws.
  7. 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 comply with seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.4 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 099123 "Interior 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 270528.29

## SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Color and legend requirements for labels and signs.
  - 2. Labels.
  - 3. Tapes.
  - 4. Signs.
  - 5. Cable ties.
  - 6. Fasteners for labels and signs.

#### 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 communications 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:
  - 1. Outlets: Scaled drawings indicating location and proposed designation.
  - 2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
  - 3. Racks: Scaled drawings indicating location and proposed designation.
  - 4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70 and TIA 606-B.
- B. Comply with ANSI Z535.4 for safety signs and labels.
- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

### 2.2 COLOR AND LEGEND REQUIREMENTS

- A. Equipment Identification Labels:
  - 1. Black letters on a white field.
  - 2. The labels shall be machine generated
  - 3. B. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969
  - 4. Shall be preprinted or computer printed type. Hand written labels are not acceptable
  - 5. Where insert type labels are used provide clear plastic cover over label.

### 2.3 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. Champion America.
    - c. emedco.
    - d. Grafoplast Wire Markers.
    - e. HellermannTyton.
    - f. LEM Products Inc.
    - g. Marking Services, Inc.
    - h. Panduit Corp.
- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, 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.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyester flexible labels with acrylic pressure-sensitive adhesive.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Brother International Corporation.
    - c. Ideal Industries, Inc.
    - d. Panduit Corp.
  2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields 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: Polyester, 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. Brother International Corporation.
    - c. Ideal Industries, Inc.
    - d. Panduit Corp.
  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.

## 2.4 UNDERGROUND-LINE WARNING TAPE

- A. See section 260553 for requirements.

## 2.5 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.
- B. General-Purpose Cable Ties: Fungus inert, 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, except where used for color-coding.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

### 3.2 INSTALLATION

- A. Follow BSD Labeling Scheme as follows:
  - 1. Frame room number – Panel in Frame – Port on Panel, MDF will be “Frame room 1”. IDF 2 will be “Frame room 2 and will continue sequentially for any additional IDFs.
  - 2. Panels will start with “Panel 1” at the top on the Rack. If additional panels are needed in other racks, they will continue with sequential numbers.
  - 3. Port label will indicate port number position on that panel (i.e., F1-P2-26). No deviation from the district labeling scheme will be allowed.
  - 4. In telecommunications room where more than one rack is present, each rack shall receive a label starting left-to-right with “RACK-1”, “RACK-2” as so forth.
- B. Horizontal (Station) Cables:
  - 1. All cables will be labeled the same at both ends. The tag shall be secured to the sheath no more than 4 inches from the end of the cable. Each end of the UTP horizontal cables shall be labeled with the nomenclature ‘Fx-PP-NN’. Where x indicates the Frame room number, PP indicates the patch panel number, and NN indicates the port number.

- C. Fiber and Copper Backbone Cables:
  - 1. Cables shall be labeled “From” – “To”, specifically:
    - a. “From <Frame-1> to <Frame-2>”, where “Frame-1” is the originating location and “Frame-2” is the destination.
- D. Work Area Outlets (WAO): Each WAO shall be labeled at the top of the modular jack enclosure with the Telecommunication Room ID (Frame room number) of the room where the cables are terminated, patch panel and the port number (‘F#-P#-##’) where the cable is being terminated.
- E. Where WAPs are placed in the drop in ceiling the grid shall be labeled with bold black lettering on white background with ½” minimum font height.
- F. 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.
- G. Install identifying devices before installing acoustical ceilings and similar concealment.
- H. Verify identity of each item before installing identification products.
- I. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- J. Apply identification devices to surfaces that require finish after completing finish work.
- K. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
- L. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- 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.
  - 3. Provide label 6 inches from cable end.
- N. Snap-Around Labels:
  - 1. Secure tight to surface at a location with high visibility and accessibility.
  - 2. Provide label 6 inches from cable end.

O. Self-Adhesive Wraparound Labels:

1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches from cable end.

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. Underground-Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench 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.

### 3.3 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 with high visibility. Identify by system and circuit designation.

C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.

1. System legends shall be as follows:

- a. Telecommunications.

D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:

1. Wiring closet designation.
2. Colon.
3. Faceplate number.

- E. Backbone Cables: Label each cable with a vinyl-wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.
- F. Horizontal Cables: Label each cable with a vinyl-wraparound label indicating the following, in the order listed:
  - 1. Room number.
  - 2. Colon.
  - 3. Faceplate number.
- G. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.
- H. Instructional Signs: Self-adhesive labels.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels.
  - 1. Apply to exterior of door, cover, or other access.
- J. Equipment Identification Labels:
  - 1. Indoor Equipment: Self-adhesive label.
  - 2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign 4 inches high.
  - 3. Equipment to Be Labeled:
    - a. Communications cabinets.
    - b. Uninterruptible power supplies.
    - c. Computer room air conditioners.
    - d. Fire-alarm and suppression equipment.
    - e. Egress points.
    - f. Power distribution components.

END OF SECTION 270553

## SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Category 6 twisted pair cable.
  - 2. Category 6A twisted pair cable.
  - 3. Twisted pair cable hardware, including plugs and jacks.
  - 4. Multiuser telecommunications outlet assembly.
  - 5. Cable management system.
  - 6. Cabling identification products.
  - 7. Grounding provisions for twisted pair cable.
  - 8. Source quality control requirements for twisted pair cable.

#### 1.3 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. FTP: Shielded twisted pair.
- D. F/FTP: Overall foil screened cable with foil screened twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. LAN: Local area network.
- H. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

- J. RCDD: Registered Communications Distribution Designer.
- K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- M. S/FTP: Overall braid screened cable with foil screened twisted pair.
- N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- O. UTP: Unscreened (unshielded) twisted pair.

#### 1.4 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
  - 1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
  - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
  - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. A work area is approximately 100 sq. ft. and includes the components that extend from the equipment outlets to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
  - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
  - 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
  - 3. Cabling administration Drawings and printouts.
  - 4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

- a. Telecommunications rooms plans and elevations.
  - b. Telecommunications pathways.
  - c. Telecommunications system access points.
  - d. Telecommunications grounding system.
  - e. Telecommunications conductor drop locations.
  - f. Typical telecommunications details.
- C. Twisted pair cable testing plan.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, installation supervisor, and field inspector.
- B. Product Certificates: For each type of product.
- C. Source quality-control reports.
- D. Field quality-control reports.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.
- B. Software and Firmware Operational Documentation:
  - 1. Software operating and upgrade manuals.
  - 2. Program Software Backup: On USB media or compact disk, complete with data files.
  - 3. Device address list.
  - 4. Printout of software application and graphic screens.

#### 1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Connecting Blocks: one of each type.
  - 2. Faceplates: one of each type.
  - 3. Jacks: Ten of each type.

#### 1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
  - 1. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

#### 1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

#### 1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

#### 1.12 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

#### 1.13 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 operating system. 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

### 2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-B.

### 2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
  - 1. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway.
  - 2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
  - 3. Communications, Non-plenum: Type CMR complying with UL 1666.
- B. 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.
- C. RoHS compliant.

### 2.3 CATEGORY 6 TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AMP NETCONNECT; a TE Connectivity Ltd. company.
  - 2. Belden CDT Networking Division/NORDX.
  - 3. Berk-Tek Leviton; a Nexans/Leviton alliance.
  - 4. CommScope, Inc.
  - 5. General Cable; General Cable Corporation.
  - 6. Hitachi Cable America Inc.

7. Mohawk; a division of Belden Networking, Inc.
8. Superior Essex Inc.
- C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP).
- F. Cable Rating: Plenum.
- G. Jacket: White for Wifi thermoplastic.

## 2.4 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. General Requirements for Twisted Pair Cable Hardware:
  1. Comply with the performance requirements of Category 6 and Category 6A.
  2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
  3. Cables shall be terminated with connecting hardware of same category or higher.
- C. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.
- D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
  1. Number of Terminals per Field: One for each conductor in assigned cables.
- E. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
  1. Features:
    - a. Universal T568A and T568B wiring labels.
    - b. Labeling areas adjacent to conductors.
    - c. Replaceable connectors.
    - d. 24 or 48 ports.
  2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
  3. Number of Jacks per Field: One for each four-pair cable indicated.

- F. Patch Cords: Factory-made, four-pair cables; terminated with an eight-position modular plug at each end.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
  2. Patch cords shall have color-coded boots for circuit identification.
    - a. Data – Grey
    - b. VoIP – Green
    - c. WAP – White
    - d. IP based management systems
      - 1) HVAC – Black
      - 2) Lighting – Blue
      - 3) Specialty, Stage – Orange
      - 4) Paging – Pink
      - 5) Mechanical – Purple
      - 6) AV systems – Green
      - 7) Security – Red
- G. Plugs and Plug Assemblies:
1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
  2. Standard: Comply with TIA-568-C.2.
  3. Marked to indicate transmission performance.
- H. Jacks and Jack Assemblies:
1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
  2. Designed to snap-in to a patch panel or faceplate.
  3. Standard: Comply with TIA-568-C.2.
  4. Standard Duplex locations to have one Orange and one Ivory jack.
  5. Marked to indicate transmission performance.
- I. Faceplate:
1. Two port, vertical single gang faceplates designed to mount to single gang wall boxes.
  2. Faceplate: Coordinate color with Section 262726 "Wiring Devices."
  3. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
    - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
- J. Legend:
1. Machine printed, in the field, using adhesive-tape label.

2. Snap-in, clear-label covers and machine-printed paper inserts.

- K. All standard workstation outlets shall be Cat 6 and all outlets for WAP shall be Cat 6A.

## 2.5 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.

## 2.6 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test cables on reels according to TIA-568-C.1.
- C. Factory test twisted pair cables according to TIA-568-C.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

# PART 3 - EXECUTION

## 3.1 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.
  1. Install plenum cable in environmental air spaces, including plenum ceilings.
  2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

## 3.2 INSTALLATION OF PATHWAYS

- A. Comply with Section 270528 "Pathways for Communications Systems."

- B. Comply with Section 270528.29 "Hangers and Supports for Communications Systems."
- C. Drawings indicate general arrangement of pathways and fittings.

### 3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
  - 1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
  - 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
  - 3. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
  - 4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
  - 5. MUTOA shall not be used as a cross-connect point.
  - 6. Consolidation points may be used only for making a direct connection to equipment outlets:
    - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
    - b. Locate consolidation points for twisted-pair cables at least 49 feet from communications equipment room.
  - 7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 8. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
  - 9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
  - 10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
  - 11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
  - 12. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
  - 13. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

E. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
3. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

### 3.5 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-B and NECA/BICSI-607.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

### 3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
- B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- D. Cable and Wire Identification:
  - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
  - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
  - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
  - 4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
    - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
    - b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- E. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
  1. Cables use flexible vinyl or polyester that flexes as cables are bent.

### 3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections:
  1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
  2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
    - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- F. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- G. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

- H. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- I. Prepare test and inspection reports.

END OF SECTION 271513

## SECTION 274100 - AUDIO-VIDEO SYSTEMS

### PART 1 - GENERAL

#### 1.1 WORK INCLUDED

- A. This project will include installation of classroom A/V Systems. Components may be, furnished by this contract or Owner Furnished, Contractor Installed as specified or as shown on Drawings.

#### 1.2 RELATED SECTIONS

- A. Section 270000 – Communications
- B. Section 270500 – Common Work Results for Communications
- C. Section 270528 – Pathways for Communications Systems
- D. Section 270528.29 – Hangers and Support for Communications Systems
- E. Section 274123 – Audio-Video Accessories

#### 1.3 CLASSROOM AUDIO PRODUCT CONTACT

- A. Classroom audio (sound reinforcement) components shall be from LightSPEED Technologies. Contact for this project is:

LightSPEED  
Classroom Audio Consultant  
11509 SW Herman Road  
Tualatin, Oregon 97062

#### 1.4 VIDEO SYSTEM

- A. Library shall have projection capabilities and supporting infrastructure.
- B. All classrooms and shall have TV displays and supporting infrastructure.

## 1.5 CLASSROOM AUDIO CABLING

- A. Cables shall terminate in the classroom audio faceplate, as shown on drawings.

## 1.6 CABLE RACEWAYS

- A. All raceway routing and mounting height information shall be coordinated with the Electrical and Architectural Drawings

## 1.7 SYSTEM CONTROL

- A. The operation shall be automated through the Owner provided classroom computer and projector remote control and shall not, typically, require adjustments or user intervention.
- B. Audio Visual Playback – System shall be capable of playing DVD/PC based media, from Owner provided source equipment

# PART 2 - PRODUCTS

## 2.1 SOUND REINFORCEMENT UNITS

- A. Classrooms will receive a sound reinforcement system. Units will be LightSPEED 955. Systems will include PageFirst™ option.
  - 1. System are to be placed as per drawings.
  - 2. System shall include LightSPEED Media Connector.
  - 3. Ceiling mount speakers are to be placed as per drawings. Speaker assembly consists of the following Atlas components:
    - a. Speaker (FA-136).
    - b. Back can (FA95-6).
    - c. Tile support (FA81-6).
    - d. Speaker grille (FA51-6).
  - 4. Wall mount speakers are to be placed as per drawings. Lightspeed WMQ or approved.
  - 5. Include power supply, and cables, Media Connector and speakers.
  - 6. One Flexmike volume control lanyard microphone and one Sharemike handheld classroom microphone, with batteries and charger.
  - 7. System shall include LightSPEED PageFirst™ Option.

## 2.2 ANCILLARY COMPONENTS

- A. Supply all ancillary cables, patch cords and adapters necessary to provide a completely functional system. See Section 27 41 23 Audio-Video Accessories for additional information.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. A complete system shall be installed in strict accordance with manufacturer's recommendations.
- B. All wiring shall be installed in raceways within walls where at all possible. Exposed cabling is not acceptable.
- C. All wiring shall be plenum rated, where routed through plenum ceiling areas.

### 3.2 CERTIFIED INSTALLATION CONTRACTOR REQUIREMENT

- A. All LightSPEED components to be installed by a certified contractor to preserve factory warranty.

### 3.3 CABLE PLACEMENT AND PATHWAYS

- A. All cables must be completely enclosed (or above the dropped ceiling where applicable).
- B. Cables may be run in the area above the dropped ceiling. In such areas, cables are to be supported by Caddy® fasteners / hangers at intervals not exceeding 48 inches.

### 3.4 INSPECTION AND TEST UPON COMPLETION

- A. Check-out and final connections to the audio system shall be made by a factory trained technician certified by the manufacturer of the products installed. In addition, factory trained technicians shall demonstrate operation of the complete system and each major component to the Owner.
- B. System field wiring diagrams shall be provided to this subcontractor by the system manufacturer prior to installation.
- C. Training – this contract shall provide training for not less than three District staff members. Training will include all aspects of the system as well as complete documentation covering all components requiring operator control or intervention.

### 3.5 WARRANTY

- A. All materials and installation shall be guaranteed for a minimum of one year from installation. Warranty work will be performed "on-site" at no cost to the Owner.
- B. Upon completion of the installation, two (2) copies of complete operational instructions shall be furnished. Instructions shall include part numbers and names, addresses, and telephone numbers of parts source.
- C. Upon completion of the installation of the equipment, the Contractor shall provide to the Owner a signed statement from the equipment supplier that the system has been wired, tested, and functions properly according to the specifications.
- D. Nothing herein contained shall be construed to relieve the Contractor from furnishing a complete and acceptable electrical wiring system in all its categories. The Owner or the Owner's Representative will condemn and reject any materials or labor which are or may become detrimental to the accomplishment of the intentions of these specifications.

END OF SECTION 274100

## SECTION 274123 - AUDIO-VIDEO ACCESSORIES

### PART 1 - GENERAL

#### 1.1 SYSTEM OVERVIEW

- A. This project will include installation of multiple projectors as called out on the drawings. The mounting brackets and projectors will be Owner Furnished, Contractor Installed.
- B. Procure and supply components to provide a complete connectivity solution between the projector and presentation station location annotated on the drawings.

#### 1.2 DEVICE REQUIREMENTS

- A. The projector will be connected to power via supplied cord. Coordinate power on testing and focusing with Owner.

#### 1.3 Related Sections

- A. Section 270000 – Communications
- B. Section 270500 – Common Work Results for Communications
- C. Section 270528 – Pathways for Communications Systems
- D. Section 270528.29 – Hangers and Support for Communications Systems
- E. Section 270553 – Identification for Communication Systems
- F. Section 271513 – Communications Copper Horizontal Cabling
- G. Section 274100 - Audio-Video Systems

#### 1.4 PRESENTATION STATION BACKBOXES

- A. Backboxes are those mounted as shown on the drawings.

## PART 2 - PRODUCTS

### 2.1 DEVICE MOUNTS AND INSTALLATION

- A. This contract shall supply:
1. Extron USFM 100. The USFM 100 is a mounting kit for suspending ultra-short throw projectors from a wall. One each per display location as shown on drawings.
  2. Extron UPB 125 universal projector bracket. One each per display location as shown on drawings.
  3. Extron PCM 340. The PCM 340 is a mounting kit for suspending projectors from an ACT ceiling. One each per display location as shown on drawings.
- B. Elevation details to be coordinated with Architect and Electrical Engineer in each location prior to mounting.

### 2.2 AUDIO CABLING

- A. Audio cable as shown on the drawings. Field verify final placement prior to installation. Provide one set of cable assemblies per room.
- B. Stereo audio connection between the presenter location and the LightSPEED Amplifier.
- C. Stereo audio connection between the classroom projector and the LightSPEED Amplifier,

### 2.3 VIDEO CABLING

- A. Video cable as shown on the Drawings. Provide one set of cable assemblies per room.
- B. Category 6 cable and extenders as required:
1. Hubbell HDMI 1080P Extender, #IMH110ST2W
  2. Hubbell USB Extender, #IMU1101W
  3. Hubbell VGA Extender, #IMU15311015W
  4. Hubbell RCA Left/Right Audio Extender, #IMAR101W
- C. Blank inserts as required, #IMB05W Blank, white, Package of 5.
- D. Category 6 cable between each projector and the closest Telecommunications Room.

## 2.4 PATCH CORDS

A. Provide the following patch cords:

1. RCA Stereo Audio Patch Cords (Red/White connector)

Length	3'	7'
Quantity	35	15

2. HDMI Patch Cords

Length	3'	7'
Quantity	35	15

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. A complete system shall be installed in accordance with manufacturer's recommendations.
- B. Wiring shall be in raceways within walls. Surface mounted raceway is not acceptable
- C. All wiring shall be plenum rated, where routed through plenum ceiling areas.

### 3.2 PROJECTOR BRACKET

- A. Mount as per manufacturer's instructions supplied with mounting kit.

### 3.3 CABLE PLACEMENT, PATHWAYS AND PATCHING

- A. All cables must be completely enclosed (or above the dropped ceiling where applicable) except for the patch cables that transition between the faceplate and the Device.
- B. Cables may be run in the area above the dropped ceiling. In such areas, cables are to be supported by Caddy® fasteners / hangers at intervals not exceeding 48 inches. Extra slack shall not be "stored" exposed at the projector.
- C. Patch HDMI and RCA cords between the wall plate and the device at each location.
- D. The display will have an Ethernet connection. This contract shall connect the device to the telecommunications outlet.
- E. This contract shall connect an audio output from this device to an audio input on the LightSPEED 885.

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- F. This contract shall extend HDMI, VGA, USB and two RCA inputs from a presentation station to the inputs on this device. See drawings for additional details.

### 3.4 INSPECTION AND TEST UPON COMPLETION

- A. All audio and video connections shall be tested, specifically
1. By means of a HDMI enabled device connected to the projector
  2. By means of a VGA/PC video signal connected to the projector
  3. By means of a USB signal to the projector

### 3.5 SYSTEM DOCUMENTATION AND AS-BUILTS

- A. Contractor shall provide a complete set of system documentation bound into a three-ring manual with a table of contents and tabs for each piece of equipment. As-built documentation shall be generated in AutoCAD® version 2010 or later and provided in hard copy as well as electronically on CD.

### 3.6 WARRANTY

- A. All materials and installation shall be guaranteed for a minimum of one year from installation. Warranty work will be performed “on-site” at no cost to the Owner.
- B. Nothing herein contained shall be construed to relieve the Contractor from furnishing a complete and acceptable electrical wiring system in all its categories. The Owner or the Owner’s Representative will condemn and reject any materials or labor which are or may become detrimental to the accomplishment of the intentions of these specifications.

END OF SECTION 274123

## SECTION 275113 - PAGING SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY OF WORK

- A. It is the intent of this Section in conjunction with the applicable Drawings is to provide paging devices to support existing paging system at the school. All locations, as detailed on the Drawings, shall be tested and balanced as to provide a reasonable level of volume to accommodate the paging needs of the school. This includes classrooms and, where specified, exterior areas of the building.

#### 1.2 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment for integration into existing school paging systems called for in the specifications and Drawings. Not all sections may be applicable but are provided to show overall system functionality.
  - 1. Public address system amplifiers, zone controls, back boxes, and all equipment, cabling and support required to interface the Public Address System to the Owner's Telephone System (Not included in this contract).
  - 2. Public Address System Speakers, ceiling mounted, wall mounted horn, both interior and exterior.
  - 3. Volume attenuators where shown on the drawings to adjust the PA speaker sound level.
  - 4. Messaging calendar clock capable of receiving and scrolling up to 64 character custom messages without affecting or replacing display of time segments.
  - 5. No call boxes, one way paging only. Call backs will be via the phone system.
  - 6. Interactive Graphical User Interface (IGUI) to intercom functions including zone or all page, selecting and distributing program sources to predefined zones or all zones and facilitating single action activation of multiple system interface e.g. access control and CCTV or other systems as directed by Owner.

#### 1.3 QUALITY ASSURANCE

- A. The Contractor shall currently maintain a locally run business for a minimum of five years and shall be an authorized distributor of the supplied equipment with full warranty privileges.
- B. The Contractor shall maintain at his facility the necessary spare parts in the proper proportion as recommended by the equipment manufacturer to maintain and service the equipment being supplied.
- C. Contractor shall have attended the manufacturer's installation and service school.

- D. The Contractor shall furnish manufacturer's manuals of the completed system including individual specification sheets, schematics, inter-panel and intra-panel wiring diagrams. In addition, all information necessary for the proper operation of the system must be included. Any bidder using other than the specified equipment must provide this information prior to bidding.
- E. As built drawings that include any changes to wiring, wiring designations, junction box labeling and any other pertinent information shall be supplied both electronically in AutoCAD® 2010 (or later) and as a full size (30" x 42") drawing upon completion of project.

#### 1.4 IN SERVICE TRAINING

- A. The Contractor shall furnish a minimum of four hours of in service training with the system. These sessions shall be broken into segments that will facilitate the training of individuals in operating station equipment, administrative devices, user programming functions, and program distribution equipment. Operating manuals and users guides shall be provided at the time of the training.

#### 1.5 MAINTENANCE SERVICE

- A. The Contractor shall provide a one-year guarantee of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner. Guarantee period shall begin on the date of acceptance by the Owner or engineer.
- B. A maintenance contract offering continued factory authorized service of this system shall be made available if requested by the Owner.

#### 1.6 SUBMITTALS

- A. Data sheets shall be provided on all equipment being provided.
- B. Internal control cabinet drawings showing internal block diagram connections shall be provided.
- C. Wiring diagrams, detailing wiring for power, signal, and control, differentiating clearly between manufacturers installed wiring and field installed wiring. Identify terminals to facilitate installation, operation and maintenance.
- D. Provide a riser diagram for the system showing in technically accurate detail all connections, interconnections, and all provisions available and made for adaptability of all specified future functions and including all calculations, charts, and test data necessary to demonstrate that all systems and system components deliver the specified signals, grades, and levels at all required points and locations.

## 1.7 REGULATORY REQUIREMENTS

- A. The entire installation shall comply with all applicable and safety codes. All central equipment and additional applicable equipment shall be listed by Underwriters' Laboratories, per US requirements. Note: Furnish an original, dated specimen of the test agency's listing card with the submittal.
- B. All equipment with digital apparatus (microprocessors) that generate and use timing signals at a rate in excess of 9,000 pulses per second to compute and operate must be Federal Communications Commission (FCC) and DOC CSA standards C108.8 (Electromagnetic Emissions) compliant. Any non-compliant equipment supplied or installed shall not be accepted and shall nullify the contract. Note: Provide documents supporting and verifying compliance.
- C. Systems shall be considered non-compliant unless they completely meet the criteria as outlined in this section. All supporting documentation shall be included as part of the initial submittal package. Letters regarding "future approval" or "approval pending" shall not be considered.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. All materials and equipment installed under this contract shall be new, unused, free of defects, and of current manufacture. Equipment and material shall carry Underwriters Laboratory (UL®) certification if required by local, state or national codes.
- B. Interface with clock system for time synchronization.
- C. Provide an amplifier circuit for each of the paging zones. Provide separate paging zones as shown on drawings.
- D. Pre-announce tones will alert the listeners of incoming calls with distinct tones for each priority level. To prevent unauthorized monitoring, the tone will sound whenever an area is being monitored, and will repeat at regular intervals. Facilities shall also be provided to defeat the tone repeat function from the console if it is not desired.
- E. Emergency and All Call paging and a minimum of 32 zones of group paging - The paging zones shall be independent of the time tone and audio program distribution zones and a minimum of 8 clock messaging zone. Systems sharing zones for both paging and tone shall not be acceptable.
- F. The paging speaker shall be 8" or 6" as defined below with integral transformer assembly. Provide with metal baffles and enclosures
- G. Weatherproof outside paging loudspeakers shall have a minimum power rating of five (5) watts. The speaker shall have a minimum frequency response of 80-10KHz and a dispersion angle of 120 x 60 degrees.

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- H. It shall be possible to distribute paging, time tone class change, or emergency signal to all classrooms and (8) additional specific paging zone groups of rooms as programmed into the system software.
- I. All programmable functions shall be located in battery backed ram to prevent loss in a power failure condition

## 2.2 PRE-APPROVED COMPONENTS

- A. System shall be based on Ashly Protea software, IP paging speaker clock combination devices with two-way microphone, analog speakers, analog horns, line level interface modules and 2-channel amplifiers.

## 2.3 INTERCOM SPEAKERS

- A. IP Intercom Speaker Digital Clock Combination Device: (CLASSROOM SPACES SYMBOL IS THE LETTER "I" WITHIN A BOX)
  - 1. Intercom digital clock speaker shall be IP enabled with an 8-pin modular connection and shall be powered utilizing Power-over-Ethernet (PoE). The speaker shall have an internal microphone with the capability for two-way communication utilizing an omni-directional subminiature electret condenser microphone.
  - 2. The device shall contain a factory assembled loud speaker, LED readout with dot matrix 32x8 display and 40 LEDs per character for the clock and text messaging notification in the color red, baffle and PCB amplifier.
  - 3. The amplifier shall provide 9 watts into the 8 ohm loudspeaker with 9 volt DC minimum power from the Ethernet PoE switch. Loudspeaker shall be dual cone 8 inch with a 10 ounce ceramic magnet. Provide back box enclosure for flush mount and surface mount installations. Back box enclosure for surface mount conditions shall match the color of the speaker grill.
  - 4. Coordinate color of the device with Architect's interior designer.
    - a. Approved is Atlas Sound, Part No. I8SCM+ or Rauland equal.
  - 5. Backbox for IP Intercom Speaker Digital Clock Combination Device:
    - a. Flush Mount Straight Enclosure, Atlas Sound Part No. FEST-I8SC or Rauland equal.
    - b. Surface Mount Straight Enclosure, Atlas Sound Part No. SEST-I8SC or Rauland equal.
- B. Interior Intercom Analog Speakers: (GENERAL PAGING SPEAKER SYMBOL IS THE LETTER "P" WITHIN A BOX)
  - 1. Interior speakers for wall mount and ceiling mount applications shall be 8-inch permanent magnet cone-type having a viscous-damped cone and a ceramic magnet

weighing a minimum 10-ounces. The speaker assembly shall be equipped with a dual-winding, 25 volt/70 volt line matching transformer. Transformers shall provide 0.5, 1 and 2 watt power taps for both 25 volt and 70 volt operation. The speaker assembly shall include a CRS white powder coated baffle with concealed loudspeaker mounting studs and includes screw mount hardware.

a. Speakers in Classrooms:

- 1) Speaker: Atlas Sound, Part No. FA136 or Rauland equal.
- 2) Grill: Atlas Sound, Part No. FA51-6 or Rauland equal.
- 3) Tile Bridge: Atlas Sound, Part No. FA81-6 or Rauland equal.
- 4) Enclosure: Atlas Sound, Part No. FA95-6 or Rauland equal.

C. Ceiling Mounted Speaker Enclosures:

1. Enclosures for ceiling installations shall include pre-mounted brackets, attachment hardware, and support rails. It shall be capable of transferring the combined weight of the loudspeaker assembly to the ceiling's support members via adjustable rails.

Unit shall be of welded steel construction, finished in textured black epoxy, and be undercoated to guard against acoustical and mechanical resonance. Unit shall also be equipped with conduit knockouts.

- a. Approved is Atlas Sound, Part No. EZ96-8 interior drop ceiling or Rauland equal.

D. Exterior Intercom Weatherproof Vandal Resistant Speaker: (WALL MOUNT EXTERIOR SPEAKER)

1. Exterior speakers for wall mount applications shall be installed on the exterior of the building, and shall be horns with back boxes and cast metal grilles. The loudspeaker shall be of the flush mount weatherproof type and all exposed metal parts shall be heavily plated and sealed.

- a. The loudspeaker shall have a full range audio power rating of 15 watts. A rubber gasket for providing a weatherproof seal between speaker flange and mounting surface shall be furnished.

2. The loudspeaker shall have an integral transformer capable of delivering its full rated power within +1.0 dB, 100 Hz to 10 kHz. The primary taps shall have power taps of 5, 2.5, 1.25, .625 and .3125 watts. The secondary impedance shall be 8 ohms.

- a. Approved is Rauland ACC1411 with ACC1105 Flush mount square back-box.

E. Vandal-Proof Exterior Grille / Enclosure:

1. Provide vandal-proof exterior speaker grille. The square front of the grille shall be manufactured from a special self-aging aluminum alloy which has a tensile strength of

- 44,000 psi. Each grille shall have a heavy gauge cold rolled steel perforated screen to protect the speaker from vandal damage. The four mounting holes shall be counter sunk.
2. The grille shall be furnished with tamper proof hardware to prevent unauthorized entry to the grill interior. Coordinate with Architect to match the exterior finishes of the structure. The flush enclosure shall be constructed of 18-gauge stainless steel.
    - a. Approved Rauland ACC1411 with ACC1105 Flush mount square back-box and carbon steel baffle.

## 2.4 INTERCOM AMPLIFICATION AND CONTROLLERS

### A. Intercom Paging Amplifier:

1. Provide high power dual channel amplifier with channel separation and low distortion, capable of supporting two channels. Amplifier shall be flexible in providing wattage outputs from 160 watts to 600 watts based upon the configuration selection.
2. Amplifier shall have stepped attenuators to provide gain setting repeatability, rear mounted barrier strips for inputs and outputs and XLR input connectors. Amplifier shall be capable of providing stereo, bridge or parallel operating modes and 25 volt, 70.7 volt, 100 volt and direct coupled 2, 4 and 8 Ohm outputs. Amplifier shall have independent power supplies and shall be rack mounted in a three rack unit dimension.
  - a. Basis of design is Ashly NE Series and Ashly NX series, or approved equal.

### B. Intercom Zone Controllers:

1. Provide intercom zone controller to provide an IP addressable end point connection for a series of analog speakers or connection to existing analog intercom headend cabinets for line level audio output. Controller shall be capable of supporting 25 volt, 70.7 volt or 100 volt speakers or paging horn devices.
2. Controller shall provide connections to paging amplifiers that support analog speakers in a total distance of 328 feet. The controller power shall be PoE and the output shall be a balanced line level with a 3 pole terminal block located at the rear of the controller.
3. Controller shall be rack mounted in a one rack unit dimension.
4. Provide one controller for each zone and connect to the corresponding paging amplifier.
  - a. Basis of design: Rauland:
    - 1) Rauland TCC200.
    - 2) Rauland TCC2022.
    - 3) Rauland TCC2033.
    - 4) Rauland TCC2099.
    - 5) Or approved equal.

### C. Administrative Console:

1. Console provides a single point for administration of paging functions.

- a. Basis of design Rauland TCC2044 or approved equal.

## 2.5 LAN/WAN CONNECTIVITY

- A. Controller access and operation shall be one hundred percent compatible with IEEE 802.3 Ethernet and be equipped a LAN port for offsite programming and diagnostics.
- B. System must have the capability to add optional remote stations / power supplies with LAN connectivity to main controller. Basis of Design: Rauland TCC2055 or approved equal.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Complete system shall be installed in strict accordance with manufacturer's recommendations.
- B. All wiring shall be installed in raceways or plenum rated, where routed through plenum ceiling areas.
- C. Each IP intercom speaker clock device shall be connected to the horizontal crossconnect in a telecommunications room with horizontal cabling installed in a star topology.
- D. Horizontal cabling shall be installed in continuous runs from the Telecommunications Rooms to the IP intercom speaker clock device locations. Splices are not permitted.
- E. All cable shall be as per manufacturer specification.
- F. Provide connection to the access control panel for distribution of emergency tones associated with lockdowns, etc.

### 3.2 DISTRICT COORDINATION

- A. Contractor shall be responsible for coordination of all IP address requirements with District.
- B. Contractor shall coordinate all routing and firewall requirements and verify proper operation with District IT staff.

### 3.3 INSPECTION AND TEST UPON COMPLETION

- A. Check-out and final connections to the system shall be made by a factory trained technician in the employ of a manufacturer of the products installed. In addition, factory trained technicians shall demonstrate operation of the complete system and each major component to the Owner. At a minimum, the following must be demonstrated:

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1. Paging of each zone to verify volume and clarity of message
  2. Synchronization of clocks, bells and paging to same (exact) time
  3. Paging from telephone handsets from any location within the school
  4. Ability to program multiple, different schedules for bells to heard throughout he buildings speakers and horns
  5. Remote access capability
- B. System field wiring diagrams shall be provided to this subcontractor by the system manufacturer prior to installation.
- C. All materials and installation shall be guaranteed to be free of defects in material and workmanship for one year after final acceptance of installation and test.
- D. As-built drawings: 3 sets. They should include up-to-date drawings that include any changes made to the existing system during installation. Circuit diagrams and other information necessary for the proper operation and maintenance of the system shall be included. Drawings must be provided on CD in AutoCAD® 2010 format.
- A. Unless there are any new components not provided in the original scope, provide supplement to existing Operation and Maintenance manual.
- E. Upon completion of the installation of the equipment, the Contractor shall provide to the Owner's Representative a signed statement from the equipment supplier that the system has been wired, tested, and functions properly according to the specifications.
- F. Nothing herein contained shall be construed to relieve the Contractor from furnishing a complete and acceptable electrical wiring system in all its categories. The Owner or the Owner's Representative will condemn and reject any materials or labor which are or may become detrimental to the accomplishment of the intentions of these specifications.

END OF SECTION 275113

## SECTION 275313 - CLOCK SYSTEM

### PART 1 - GENERAL REQUIREMENTS

#### 1.1 GENERAL

- A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.
- B. This section may be combined with 275113 by utilizing a complete InformaCast® package that integrates clock, scheduling, and bells functionality in a single platform.

#### 1.2 WORK INCLUDED

- A. Wireless Synchronized Devices
  - 1. Analog Clock.

#### 1.3 RELATED SECTIONS

- A. Section 270000 – Communications.
- B. Section 275113 – Paging System.

#### 1.4 QUALITY ASSURANCE

- A. All clocks and associated equipment shall be installed in a neat and workmanlike manner.
- B. All secondary clocks will be tested and certified for synchronization and Daylight Savings Time adjustment.

#### 1.5 DEFINITIONS

- A. GPS: Global Positioning System, a worldwide system that employs 24 satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits atomic time, the most accurate and reliable time.

#### 1.6 SYSTEM DESCRIPTION

- A. GPS synchronized wireless time system shall continually synchronize clocks, data display units and PA speakers time throughout the facility and wireless PA voice messaging where needed.

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- B. The system shall synchronize all clocks to each other. The system shall utilize GPS technology to provide atomic time to all its components. The system shall not require any hard wiring (beside AC power) for all its components. Analog clocks shall be battery operated. Clocks shall automatically adjust for Daylight Savings Time.
- C. The system shall provide a text messaging to a specific or group of Alphanumeric Data Display units.
- D. Analog Clocks shall be synchronized within 2 milliseconds up to 6 times per day, and each clock shall have an internal oscillator that maintains plus or minus one second per day between synchronizations, so that overall clock accuracy shall not exceed plus or minus 0.05 seconds.
- E. The system shall include an internal real time clock reference so that failure of the GPS signal shall not cause the clocks to fail in indicating the right time.
- F. The system shall provide an 802.3 Ethernet based network interface to enable system remote programming and maintenance.
- G. The system shall incorporate a “fail-proof” design so that a temporary power interruption shall not cause failure of the all system. Upon restoration of power, the system shall resume normal operation without the need to reset the system or any of its components.
- H. The system shall include a test pager, to notify maintenance personnel of any system malfunction.

#### 1.7 REGULATORY REQUIREMENTS

- A. Equipment and components furnished shall be of manufacturer’s latest model.
- B. Encoder, Transmitter and receiver shall comply with Part 90 of FCC rules, as follows:
  - 1. This device may not cause harmful interference, and
  - 2. This device must accept interference received, including interference that may cause undesired operation.
  - 3. Transmitter frequency shall be governed by FCC Part 90.35.
  - 4. Transmitter output power shall be governed by FCC Parts 90 and 74.
- C. System shall be installed in compliance with local and state authorities having jurisdiction.

#### 1.8 SUBMITTALS

- A. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors and finishes of clocks.
- B. Operating License: If license is required, submit evidence of application for operating license prior to installing equipment. Furnish the license, or if the license has not been received, a copy

of the application for the license, to the Owner prior to operating the equipment. When license is received, deliver original license to Owner.

- C. Samples: Submit one clock for approval. Approved sample shall be tagged and shall be installed at the location directed.
- D. Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions.

#### 1.9 SUBSTITUTIONS

- A. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.
- B. Proposed substitutions shall be identified not less than 10 days prior to bid date.
- C. Other systems requiring wiring and/or conduit between master and clocks will not be acceptable.

#### 1.10 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Manufacturer: Company specializing in manufacturing commercial wireless systems with a documented experience of minimum of 10 continuous years.
  - 2. Installer: Company with documented experience in installation of commercial wireless systems.

#### 1.11 DELIVERY STORAGE AND HANDLING

- A. Deliver all components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number, and other related information.
- B. Store equipment in finished building, unopened containers until ready for installation.

1.12 PROJECT SITE CONDITIONS

- A. Clocks shall not be installed until painting and other finish work in each room is complete.
- B. Coordinate installation of GPS receiver and external antenna (if used) for access to the roof or exterior side-wall so that the bracket and related fasteners are watertight.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. GPS synchronized wireless time, voice and data system and its components shall be manufactured by Primex.

2.2 DESCRIPTION

Clock System: The scope of this project includes clocks to support existing system at the school. Not all sections may be applicable but are provided to show overall system functionality.

2.3 CLOCK CONTROLLER

- A. Wireless controller and synchronization unit shall be Primex that possesses all of the following features:
  - 1. Able to receive clock from a Local Area Network (Ethernet) connection with a wireless NTP Atomic time synchronization as backup.
  - 2. Single transmitter for facility wide coverage.
  - 3. Automatic Daylight Saving Time clock adjustments.
  - 4. Remotely accessible and programmable via IP interface.
  - 5. Internal -10W UHF transmitter.
  - 6. External 350W power amplifier.

2.4 ANALOG CLOCKS

- A. Each classroom shall have a 12" (minimum) Wireless Synchronized Analog Clock that possesses all of the following features:
  - 1. Dimensions: 12" Diameter, 1.65" Deep.
  - 2. Power options: Two D Batteries.
  - 3. Operating Temperature: 32° to 120°F.
  - 4. Humidity: 0%-95% Non-condensing.
  - 5. Frame and lens: Polycarbonate durable frame with tempered glass crystal lens.
  - 6. Viewing distance: Up to 100 feet.

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7. Clock face: White with Black hands and Sweep.
8. Frequency: 148-174 MHz, 400-470 MHz.
9. Paging format: POCSAG, Narrow band.
10. Synchronization rate: 1 or 6 Times/Day (user selectable).
11. Receiver Sensitivity: 10uV/M.
12. Channel spacing: 12.5 KHz.
13. Warranty: One year on parts and labor (minimum).
14. Approvals: UL<sup>®</sup> Listed as well as FCC Part 15 Class A and CE Marked.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Provide Clocks in all rooms as adjacent to paging speakers. Final placement may be field determined. Coordinate with Architect elevations.

#### 3.2 START-UP

- A. Synchronize secondary clocks with master clock and Intercom System.
- B. Cycle through Daylight Savings Time and verify correct time change on all clocks. Document results and include in as-built documentation.

END OF SECTION 275313

## SECTION 275319 - DISTRIBUTED ANTENNA SYSTEM (DAS)

### 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 specification describes technical and performance criteria for deploying a Distributed Antenna System (DAS) capable of supporting Public Safety Networks (PSN).
- B. Prior to installation, Contractor shall confirm with AHJ if DAS is required for Sato ES Addition. Coordinate necessary testing and site construction requirements with AHJ and Beaverton School District.
- C. The DAS components specified in this document include:
  - 1. Bi-Directional Amplifiers (BDA),
  - 2. Fiber-Optic Master Unit
  - 3. cable/remote units
  - 4. Donor Antennas,
  - 5. Coverage Antennas,
  - 6. Coaxial Cable and Coax Connectors
  - 7. Splitters, Combiners, and Couplers,

#### 1.3 RELATED SECTIONS

- A. 270526 Grounding and Bonding for Communications Systems
- B. 270528 Pathways for Communications Systems
- C. 270528.29 Hangers and Supports for Communications Systems
- D. 271323 Communications Optical Fiber Backbone Cabling

#### 1.4 SYSTEM DESCRIPTION

- A. Services: Upon system acceptance testing, the DAS shall provide coverage for the PSNs listed below:

<u>Service</u>	<u>Uplink, MHz</u>	<u>Downlink, MHz</u>
800 Band	806 - 824	851 - 869

- B. PSN Approval: The Contractor shall propose and deploy a DAS system capable of receiving approval of Washington County Consolidated Communications (WCCCA) which is the PSN Authority Having Jurisdiction (AHJ) - .
- C. Active Fiber DAS Distribution (If required): Single-mode fiber-optic cable shall be used for active distribution. In-line amplifiers are not allowed.
- D. Network Management:
  - 1. NMS: The DAS shall have a Network Management System (NMS) capable of alarm, monitor, configuration and control of all Active Components of the DAS system.
  - 2. NMS shall also be capable of monitoring toh following:
    - a. Low battery condition on UPS
    - b. Battery charger failure on UPS
    - c. Output from UPS
    - d. Output from emergency generator
  - 3. The DAS Electronics shall provide the following outputs for monitoring by the Fire Alarm System:
    - a. Donor Antenna Malfunction
    - b. Signal booster Failure
    - c. Signal booster fault.
    - d. Loss of AC Power

## 1.5 PERFORMANCE REQUIREMENTS

### A. PUBLIC SAFETY NETWORK (PSN) DAS:

- 1. The PSN DAS shall comply with IFC 510 {2009}{2012} and NFPA-72 2013 Edition.
- 2. The DAS shall deliver coverage per the criteria below throughout 95% of all occupied building spaces and 99% in critical areas as defined in NFPA 72.

<u>Parameters</u>	<u>Units</u>	<u>Public Safety 800 MHz</u>
Minimum Downlink RSL	dBm	-95

- 3. The DAS shall be capable of upgrade, without additional hardware or software, to allow for changes to system frequencies within the deployed frequency band in order to maintain radio system coverage as originally designed.

## 1.6 SUBMITTALS

### A. Submittal Requirements with the Bid:

#### 1. Certificates

- a. A certificate from the manufacturer of the equipment to be installed stating that the DAS installer is trained/ qualified on the equipment.

#### 2. Test Equipment

- a. Submit certificates indicating that staff is certified on required test equipment including by not necessarily limited to:

- 1) Signal Generators
- 2) Spectrum Analyzers
- 3) PIM Testers

- b. Submit current calibration data for test equipment to be used.

#### 3. Equipment cutsheets on any equipment proposed for substitution in compliance with Section 1.7 of the specifications.

#### 4. Bid Assumptions

- a. Contractors shall state the actual channel count from the local AHJ for the PSN Frequency Bands identified above with submittal of bid response. Prior to installation, contractors shall confirm the channel count and frequencies with the AHJ, and shall guarantee coverage for these channels per the criteria stated above.

### B. Submittal Requirements Prior to Start of Construction

1. Statement of Work (SOW): The contractor shall submit a SOW that has been accepted by the customer or customer's designated representative.
2. Acceptance Test Plan (ATP): The contractor shall submit an ATP that has been accepted by the customer or customer's designated representative.
3. To scale floor plans showing the location of system Components.
4. Final RF link budget
5. Detail Drawings for Donor Antenna and grounding
6. Product Data Sheets for each type of equipment to be installed.
7. Maintenance Service Contract
8. Permit drawings as required by the AHJ and Letter of Authorization from WCCCA for re-transmission of frequencies.

### C. Submittal Requirements at Close Out

#### 1. Drawings: Submit as-built drawings indicating:

- a. Donor antenna, grounding and lightning protection details

- b. Cable routing, splitters, couplers and coverage antenna locations
  - c. Active component locations, layout and configuration
- 2. Test reports shall confirm the requirements of Section 1.4 have been met.
- 3. Cable Test Reports: Submit cable test results for all cable segments. Testing shall include Return Loss (RL), Distance to Fault (DTF) and Passive Intermodulation (PIM).
- 4. Field Reports: Submit test results for all fiber runs.
- 5. Operation and Maintenance Data: Submit hardware and software manuals for all Active Components.
- 6. Acceptance Certificate or Document from the AHJ
- 7. Warranty Documents:
  - a. Submit for all manufactured components specified in this Section.
  - b. Submit Contractor's System Warranty.
  - c. Submit Manufacturer's Warranty

## 1.7 SUBSTITUTIONS

- A. Contract Documents are based on equipment manufacturers as called out in the Specifications and indicated on the Drawings. Acceptance of substitute equipment manufacturers does not relieve Contractor of the responsibility to provide equipment and materials, which meet the performance as stated or implied in the Contract Documents.
- B. Submit proposals to provide substitute materials or equipment, in writing, in compliance with Bidding and Division 1 requirements.
- C. Indicate revisions required to adapt substitutions including revisions by other trades. Substitutions that increase the cost of the work for related trades are not permitted.
- D. The proposed substitution shall conform to the size, ratings, and operating characteristics of the equipment or systems as specified and shown on the Drawings.
- E. Proposals for substitutions shall include the following information:
  - 1. Passive Components:
    - a. Product samples
    - b. Detailed product specifications
    - c. Independent test results verifying the product specifications
    - d. Written documentation from the manufacturer guaranteeing that the alternative component(s) shall remain available for new purchase for a period of 7 years from the date of system acceptance.
  - 2. Active Components:
    - a. Hardware and software manuals
    - b. Detailed product specifications

- c. Mean Time Between Failure (MTBF) data for each Active Component
- d. Written documentation from the manufacturer guaranteeing that the alternative component(s) shall be supported for a period of 2 years from the date of system acceptance.
- e. For Active Components serving the PSN, written documentation from the AHJ that the alternative component(s) are approved for use within the PSN and that system acceptance of the DAS to the PSN shall not be withheld due to the alternative component being used in the DAS.

## 1.8 CODES AND STANDARDS

- A. All work shall comply with the latest editions of the *NEC*<sup>®</sup>, National Electrical Safety Code, all applicable local rules and regulations, equipment manufacturer's instructions, and the National Electrical Contractors Association Standard of Installation. In case of discrepancy or disagreement between the documents noted above, the contractor shall satisfy the most stringent requirements. Equipment and cabling installation shall comply with the following standards. All publications must be of the latest issue and addenda:

- 1. NFPA 70 - 2014 National Electrical Code (*NEC*<sup>®</sup>)
- 2. 2009 (2012) International Fire Code
- 3. NFPA 72 - 2013 – National Fire Alarm and Signalling Code
- 4. Federal Communications Commission (FCC) - Title 47 of the Code of Federal Regulations, Part 90.
- 5. Federal Communications Commission (FCC) Rules, Parts 15 and 22
- 6. ANSI/TIA-568-D.O: Generic Telecommunications Cabling for Customer Premises
- 7. ANSI/TIA-568-D.1: Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
- 8. ANSI/TIA-568-C.2: Balanced Twisted-Pair Telecommunications Cabling and Components Standards
- 9. ANSI/ TIA-568-C. 3: Optical Fiber Cabling Components Standards
- 10. ANSI/TIA-569-D: Commercial Building Standard for Telecommunications Pathways and Spaces
- 11. ANSI/TIA-606-B: The Administration Standard for the Telecommunications Infrastructure of Commercial Building
- 12. ANSI/ TIA-607 -C: Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
- 13. *Bic**si*<sup>®</sup> Information Transport Systems Installation Methods Manual, 5th Edition
- 14. *Bic**si*<sup>®</sup> Telecommunications Distribution Methods Manual, 12th Edition

## 1.9 ABBREVIATIONS

- A. ACG: Automatic Gain Control
- B. AHJ: Authority Having Jurisdiction
- C. ATP: Acceptance Test Plan

- D. AWS: Advanced Wireless Service
- E. BDA: Bi-Direction Amplifier
- F. BRS: Broadband Radio Service
- G. BTS: Base Transceiver Station
- H. CDMA: Code Division Multiple Access
- I. C/N: Carrier-to-Noise Ratio
- J. CW: Continuous Wave
- K. CWDM: Coarse Wave Division Multiplexing
- L. DAS: Distributed Antenna System
- M. DWDM: Dense Wave Division Multiplexing
- N. EBS: Educational Broadband Service
- O. ESMR: Enhanced Specialized Mobile Radio
- P. EOS: Electrical Optical System
- Q. FCC: Federal Communications Commission
- R. GUI: Graphical User Interface
- S. iDEN: Integrated Enhanced Digital Network
- T. LMR: Land Mobile Radio
- U. MTBF: Mean Time Between Failure
- V. NFPA: National Fire Protection Association
- W. NMS: Network Management System
- X. PCS: Personal Communications System
- Y. PSN: Public Safety Network
- Z. RoF: Radio-over-Fiber
- AA. RoHS: Restriction of Hazardous Substances
- BB. RSL: Received Signal Level

- CC. SISO: Single-Input, Single-Output
- DD. SMR: Specialized Mobile Radio
- EE. SMS: Short Message Service
- FF. SNIR: Signal-to-Noise Interference Ratio
- GG. SNMP: Simple Network Management Protocol
- HH. VSWR: Voltage Standing Wave Ratio

#### 1.10 DEFINITIONS

- A. Acceptance: Expressed approval by the customer
- B. Active: DAS components that require AC/DC power for operation
- C. Carrier Approval: Expressed approval to interconnect to the WSP macro network
- D. Channel: A path for an RF transmission between two points
- E. Component: A main system element of the DAS
- F. Contractor: The prime contractor bidding the project
- G. Passive: DAS components that do not require AC/DC power for operation

#### 1.11 QUALITY ASSURANCE

- A. Source Limitations:
  - 1. Obtain equipment from a single manufacturer.
  - 2. Contractor must have an office within 100 miles of the project site.
  - 3. Contractor or systems integration partner shall provide a cost to have the following major components spared at the Owner's site:
    - a. BDA for used frequency
    - b. Fiber Optic Master Unit
    - c. Fiber Optic Remote Units
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. The work specified in this Section is acknowledged to require special skills mastered by education, experience, or both. Bidders for work described in this Section shall be or shall

subcontract with established DAS/RF communications contractors. The contractor shall have direct access to all tools and test equipment required to complete the work prior to submitting a bid.

- D. Requirements set forth by first-responder code, ordinance, or the PSN AHJ shall supersede the requirements described herein and shall be met in their entirety. It is the Contractor's responsibility to ensure that the DAS complies with local code, ordinances or requirements established by the PSN AHJ.
- E. PSN Approval
  - 1. Contractor shall be responsible for facilitating the AHJ approval(s) per the requirements of the code or ordinance.

#### 1.12 WARRANTY

- A. Manufacturer Warranty:
  - 1. Splitters, Couplers and Coverage Antennas: 2-years from date of system acceptance.
  - 2. Coaxial Cable and Connectors: 2-years from date of system acceptance.
  - 3. Fiber-Optic Cable: 20-year limited warranty from date of system acceptance.
  - 4. Active Components: 2-years from date of system installation.

#### 1.13 MAINTENANCE

- A. The Contractor shall provide a maintenance service contract, covering the system for a period of one-year with options up to five years: preventative maintenance, system monitoring, spares, fault mitigation, equipment repair, and response time.
- B. Annual Testing
  - 1. As required by Code, the system shall be tested annually beginning one (1) year from the date of final acceptance testing. The contractor or systems integrator shall provide a price for an additional service contract to include the required annual testing as described in part 3 below.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
  - 1. ADRF Technologies
  - 2. Solid Technologies
  - 3. Commscope

4. TE Connectivity
5. Axell Wireless

## 2.2 RISER HEAD END

### A. 800 MHz Bi-directional Amplifier (BDA)

1. BDA: The BDA shall be channelized and use digital filtering to mitigate interference and accommodate multiple services for PSNs.
2. Characteristics:
  - a. Operating Temperature Range: -33 °C to +50 °C
3. Filtering: Digital
  - a. Separate Control: Each RF amplifier shall be capable of adjusting and controlling power levels for each WSP when multiple WSPs share a single amplifier.
  - b. FCC Part 90.219 Type Classification: Class A channelized narrowband for LMR/SMR/ ESMR frequency bands
4. Alarming:
  - a. Shall support both SNMP and SMS using wireless modem
  - b. Shall provide dry contact connection to Fire Alarm Control Panel
5. Mounting Options: Shall support rack or wall mounting
6. Frequency Bands Supported:, 806 - 869 MHz LMR/SMR/ESMR
7. Compliance:
  - a. NFPA: The BDA shall comply with 2012 NFPA-72, chapter 24 requirements for supervision and monitoring.
  - b. FCC: Shall be FCC type certified.
  - c. All equipment shall be UL<sup>®</sup> Listed.

### B. FIBER-OPTIC MASTER UNIT:

1. When building size dictates an Active fiber DAS, the Fiber-Optic Master Unit shall convert radio over coax to Radio-Over-Fiber (RoF) for distribution to Fiber-Optic Remote Units.
2. Characteristics
  - a. Transmission Media: Single-mode fiber at 1310 nm
  - b. Operating Temperature Range: +5 °C to +40 °C
  - c. Impedence: 50 Ohm
3. Chassis:

- a. Modular design capable of supporting up to 32 Remote Units
  - b. Shall support redundant power supplies
  - c. Shall have the capability to remotely power the Remote Units via composite fiber-optic cable
4. Automatic Gain Control (AGC): Shall provide AGC for optical loss compensation
5. Optical Budget: Shall support  $\leq 3$  dB optical budget (~3 km or 2 miles)
6. Remote Supervision:
  - a. Provide line item pricing to equip the system with remote monitoring capability.
  - b. Remote capacity shall support TCP/IP protocol, SNMPv2, FTP, HTTP, Telnet, and be fully compatible with general purpose SNMP managers
  - c. Remote access shall be available via Point-to-Point Protocol (PPP), over circuit-switched/packet data and wired/wireless modems
  - d. Each Active device shall be manageable via a Web GUI
7. Frequency Bands Supported: 806 - 869 MHz LMR/SMR/ESMR

C. DONOR ANTENNA

1. Public Safety
  - a. 746-986 MHz Yagi Antenna
  - b. Electrical Specifications

Gain	11 dB or greater
VSWR	<1.7 : 1
Polarization	Vertical
Maximum Input Power	100 Watts
Electrical Downtilt	0 °
Front-back Ratio	>16 dB
Connectors	N-Female
Lightning Protection Direct	Ground
Rated Wind Speed	100 mph
Max. Dimensions of Antenna	2.2" x 10" x 36"

D. SURGE ARRESTOR

1. DC Blocked Protector
2. Flange mounted, dc block, single transmitter coaxial lightning protection for 125MHz to 1GHz with N female connectors
3. Mount Type: Flange Mount

4. Standards: CE Compliant, RoHS Compliant
5. Frequency Range: 125MHz to 1GHz
6. Protected Side Connector N Female
7. Surge Side Connector: N Female
8. Turn On Voltage: 600Vdc  $\pm$  20 %
9. VSWR:  $\leq 1.1:1$  Over Frequency Range
10. Insertion Loss:  $\leq 0.1$  dB Over Frequency Range
11. RF Power: 125 to 220 MHz @ 375 W, 220 to 700 MHz @ 125 W, 700 to 1000 MHz @ 50 W

- E. Omni-Directional Coverage - Omni-Directional Coverage antennas shall feature a multi band design, accommodating multiple frequency bands in a single small antenna.

Pattern Type:	Omnidirectional
Frequency Ranges:	698-960 and 1710-2700 MHz
Gain:	1.9dBd (4dBi) (similar at 2100MHz and 450 MHz)
VSWR:	1.2:1-1.8:1
Polarization:	Multi-Polarized
Impedance:	50 ohms nominal
Diameter:	7.5 in
Height:	7 in
Weight:	1 lb
Connector:	N-Female (others available)
Warranty:	1 Year Limited
Construction:	UV Stabilized ABS
Ground Plane:	Built In
Overall Dimensions	3 in x 3 in x 3 in
Color	Black or White
Pigtail Included	Yes
Pigtail Length	18 in
Application	In Building
Mounting Style	3/4 in stud Mount
Mounting Hardware	Optional L-Bracket Available
H. Beamwidth (deg.)	360

## 2.3 DONOR ANTENNA CABLING

### A. Construction Materials:

1. Jacket Material: Non-Halogenated, fire retardant polyolefin
2. Outer conductor material: Corrugate copper
3. Dielectric Material: Foam PE
4. Flexibility: Standard
5. Inner Conductor Material: Copper

## DISTRIBUTED ANTENNA SYSTEM (DAS)

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6. Jacket Color: Black

B. Dimensions

1. Nominal Size: (.5 inch)

C. Electrical Characteristics

1. Cable Impedance: 50 ohm  $\pm$ 1 ohm
2. Capacitance: 22.0pF/ft
3. Operating Band: 1 – 5000 MHz

D. Mechanical Specifications

1. Fire Retardancy Test Method: UL 1666/ CATVR/ CMR
2. Smoke Test Method: IEC 61034
3. Toxicity Index Test Method: IEC 60754-1/ -2

2.4 DIRECTIONAL COUPLERS

<b>Electrical Specifications</b>	
Operating Frequency Band	698 – 2700 MHz
3rd Order IMD	-140 dBc (relative to carrier)
3rd Order IMD Test Method	Two +43 dBm carriers
Average Power, maximum	200 W
Coupling Tolerance	$\pm$ 1.0 dB
Impedance	50 ohm
Insertion Loss at Frequency Band	0.3 dB @ 698–2700 MHz
Isolation at Frequency Band	20 dB @ 698–2700 MHz
Peak Power, maximum	1 kW
Reflected Power, maximum	200 W
Return Loss, minimum	19.0 dB
VSWR	1.25:1

PART 3 - EXECUTION

3.1 INSTALLATION

DISTRIBUTED ANTENNA SYSTEM (DAS)

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- A. The contractor and/ or Systems Integrator shall design, install, commission and test the DAS in accordance with the manufacturer's instructions and recommendations.
- B. Locate equipment, antennas and splitters at locations shown on the contract drawings.
- C. Extend cabling from the EOS enclosures to the splitters in a neat and orderly manner per the routing indicated on the contract drawings. Support cabling in compliance with NEC chapter 8 requirements and manufacturers recommendations.
- D. Maintain a 6" minimum distance from the DAS cabling and other cabling for parallel runs. Do not install coaxial cabling open in any areas where the cabling will be subject to physical damage.
- E. Install antennas as per the mounting details shown in the drawings.

### 3.2 EQUIPMENT MOUNTING

- A. Install wall mounted EOS Enclosures in equipment spaces as indicated on plans in accordance with manufacturers instructions and seismic requirements.
- B. Install EOS Headend equipment rack in equipment space indicated on the drawings. Fasten to the floor per manufacturers instructions and provide seismic bracing if required in compliance with local codes.
- C. Install donor antennas per details shown on the contract documents.

### 3.3 COORDINATION WITH OTHER TRADES

- A. Field coordinate the installation of the EOS headend equipment and remotes to ensure that each location is provided with the following:
  - 1. a 120V, 20A circuit for UPS equipment served from the lifesafety generator system.
  - 2. (2) strands of single mode fiber from the head end location to each remote location terminated in AC APC connectors. Coordinate fiber install with low voltage contractor.
  - 3. Grounding per *NEC*<sup>®</sup> and ANSI/TIA/607-C.
  - 4. Coordinate Alarm and Monitoring points with the Fire Alarm contractor.

### 3.4 EXAMINATION

- A. The contractor must examine areas and conditions under which DAS components are to be installed and notify the owner's representative, in writing of those conditions which are, in the Contractor's opinion, potentially detrimental to proper completion of the work. The Contractor shall not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the owner.

- B. Examine pathway elements intended for cable, check raceways, cable trays and other elements for compliance with space allocations, installations tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 1. Specific items of examination shall include, but shall not necessarily be limited to, the following:
    - a. Locations for all new DAS antennas, cable and splitter equipment.
    - b. The Contractor shall examine all rooms designated to house DAS equipment to ensure adequate space, power, and environment conditions to support installation.

### 3.5 TESTING

- A. Acceptance testing shall be performed confirming the requirements have been met.
- B. The contractor shall complete the acceptance testing as prescribed in the approved Acceptance Test Plan (ATP) submittal.
- C. Testing Procedure (PSN):
  - 1. Test Location
    - a. Each floor of the building shall be divided into a grid of 20 approximately equal test areas.
    - b. Downlink received signal level measurements shall be recorded in the coverage area using actual RSSI signal from site. Measurements shall be collected using a spectrum analyzer and a dipole antenna.
    - c. Failure of a maximum of two nonadjacent test areas shall not result in failure of the test.
    - d. In the event that three of the test area fail the test, in order to be more statistically accurate, the floor shall be divided into 40 equal equal test areas. Failure of a maximum of four non adjacent test areas shall not result in failure of the test. If the system fails the 40-area test, the system shall be altered to meet the 95% coverage.
    - e. A test location in the center of each test area shall be selected for the test. Once the location has been selected, the location shall represent the entire test area.
  - 2. Equipment Requirements
    - a. Test equipment shall be allowed to stabilize in test environment prior to calibration for a minimum of thirty minutes. Any change in temperature can void the calibration.
    - b. Signal generator must be connected to the Head end downlink (TX) interface via tested and approved coaxial cabling and connectors.
    - c. Signal generator transmits frequency (MHz) and Power (dBm) must be preapproved by project engineer prior to testing. The control channel from the base station can be used as a signal source as well.

- d. Verify that all remote units for the area under test are ON.
    - e. Test frequency and power must be recorded corresponding to the date and time of each site walk measurement.
    - f. Spectrum analyzer with unity gain (0dB, frequency specific) dipole receive antenna must be preapproved by the project engineer.
    - g. Site walk screen shots shall be saved with frequency span +/- 20 MHz relative to the center/measured frequency.
  3. Documentation
    - a. Exact location of measurement must be marked on the grid print.
    - b. Screen shots must be taken in all designated grid spaces. If more than one reading is saved per grid zone, saved results shall be distinguished from one another using Grid##"A", Grid## "B" etc.
    - c. Results of testing are reported to project engineer for analysis and reporting.
- D. Proof of Performance and Testing Methodology:
  1. Test requirements specified in this document shall be successfully completed prior to issuance of a Certificate of Occupancy and yearly thereafter. Also testing with a successful result shall occur whenever a design change is made to the system, which changes the technical performance or coverage of the system. All tests shall be coordinated 10 days in advance with the AHJ. Results of the test shall be reported in writing to the AHJ.
- E. Technical Training
  1. The Contractor shall be responsible for organizing a structured demonstration of acceptance tests to ensure organized and efficient testing.
  2. The Contractor shall provide written notice to the owner's representative at least thirty (30) calendar days in advance of the initiation of final system acceptance testing. Included in the advance notice shall be three (3) copies of the approved test plans and procedures to ensure acceptance test monitoring personnel are familiar with the tests, procedures and the expected results.
  3. It is the responsibility of the Contractor to notify the owner's representative at appropriate times to permit visual inspections of all DAS components. No Installation work shall be covered until a visual inspection has been completed.
  4. Provide the owner's representative with the opportunity to witness all testing. On reasonable request and with ten (10) working days' notice, the Contractor shall demonstrate that the test procedure competently identifies the parameter being demonstrated or the fault condition being tested.
  5. The Contractor shall provide a Certificate of Compliance signed by a responsible company representative after completion of the site installation. This document shall certify that each element of the installed system and wiring complies with the requirements of the Contract Documents and the certification shall be included with the final acceptance report.

6. The Contractor shall provide training for elements of the DAS. Such training shall include management, operational and maintenance levels and shall be provided to individuals (maximum of 3) to be designated by the owner's representative.
7. Training shall be conducted by qualified personnel fully conversant on the equipment, materials, software, and over all operation of the installed elements. Training shall be based upon as much hands-on training as is possible. The Contractor shall provide all necessary training aids and materials, which shall include written handouts.
8. All training shall be completed prior to Final Acceptance.

### 3.6 TRAINING

- A. Retain the Systems Integrator to instruct the District Personnel on the proper operation of the system including alarms.
  1. Provide time for two (2), one hour training session.

END OF SECTION 275319

## SECTION 280500 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

### 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. Electronic safety and security equipment coordination and installation.
  - 2. Common electronic safety and security installation requirements.

#### 1.3 COORDINATION

- A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:
  - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  - 3. To allow right of way for piping and conduit installed at required slope.
  - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

### PART 2 - PRODUCTS (NOT USED)

### PART 3 - EXECUTION

#### 3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

#### 3.2 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 280500

## SECTION 280513 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

### 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. UTP cabling.
  - 2. RS-232 cabling.
  - 3. RS-485 cabling.
  - 4. Low-voltage control cabling.
  - 5. Control-circuit conductors.
  - 6. Fire alarm wire and cable.
  - 7. Identification products.

#### 1.3 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).

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. For coaxial cable, include the following installation data for each type used:
    - a. Nominal OD.
    - b. Minimum bending radius.
    - c. Maximum pulling tension.

- B. Shop Drawings: Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
  - 1. Vertical and horizontal offsets and transitions.
  - 2. Clearances for access above and to side of cable trays.
  - 3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Operation and Maintenance Data: For wire and cable to include in operation and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Allowable pulling tension of cable.
  - 2. Cable connectors and terminations recommended by the manufacturer.

#### 1.5 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.
- B. 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.
- 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.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
  - 1. Test each pair of UTP cable for open and short circuits.

#### 1.7 PROJECT CONDITIONS

- A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.

1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.
- B. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

## PART 2 - PRODUCTS

### 2.1 UTP CABLE

- A. Comply with requirements in Division 27 Section "Communications Copper Horizontal Cabling" including color coding requirements for security systems.

### 2.2 RS-232 CABLE

- A. Plenum-Rated Cable: NFPA 70, Type CMP.
  1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
  2. Plastic insulation.
  3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
  4. Plastic jacket.
  5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
  6. Flame Resistance: Comply with NFPA 262.

### 2.3 RS-485 CABLE

- A. Plenum-Rated Cable: NFPA 70, Type CMP.
  1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
  2. Fluorinated ethylene propylene insulation.
  3. Unshielded.
  4. Fluorinated ethylene propylene jacket.
  5. Flame Resistance: NFPA 262, Flame Test.

### 2.4 LOW-VOLTAGE CONTROL CABLE

- A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
  1. 1 pair, twisted, No. 16 AWG, stranded (19x29) and No. 18 AWG, stranded (19x30) tinned copper conductors.

2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

## 2.5 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.
- B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

## 2.6 FIRE ALARM WIRE AND CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Comtran Corporation.
  2. Genesis Cable Products; Honeywell International, Inc.
  3. Rockbestos-Suprenant Cable Corp.
  4. West Penn Wire; a brand of Belden Inc.
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
  1. Low-Voltage Circuits: No. 16 AWG, minimum.
  2. Line-Voltage Circuits: No. 12 AWG, minimum.

## 2.7 IDENTIFICATION PRODUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Brady Corporation.
  2. HellermannTyton.
  3. Kroy LLC.

4. PANDUIT CORP.

- B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

- A. Cable Trays: Comply with NEMA VE 2 and TIA-569-B.
- B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.
- C. Comply with requirements in 260533 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
- D. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- E. Pathway Installation in Equipment Rooms:
  - 1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
  - 2. Install cable trays to route cables if conduits cannot be located in these positions.
  - 3. Secure conduits to backboard when entering room from overhead.
  - 4. Extend conduits 3 inches (75 mm) above finished floor.
  - 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- F. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems." for installation of supports for pathways, conductors and cables.

3.3 WIRING METHOD

- A. Install wiring in metal raceways and wireways. Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 3/4 inch (21 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.

- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

### 3.4 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.
- C. General Requirements for Cabling:
  - 1. Comply with TIA/EIA-568-B.1.
  - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
  - 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  - 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
  - 6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - 7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
  - 8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- D. UTP Cable Installation: Install using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.
  - 1. Comply with TIA/EIA-568-B.2.
  - 2. Install 110-style IDC termination hardware unless otherwise indicated.
  - 3. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
- E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Open cable shall not be allowed except in the telecommunications spaces.
3. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1525 mm) apart.
4. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

### 3.5 FIRE ALARM WIRING INSTALLATION

- A. Comply with NECA 1 and NFPA 72.
- B. Wiring Method: Install wiring in metal raceway according to 260533 Section "Raceway and Boxes for Electrical Systems."
  - 1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
- C. 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.
- D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- E. 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.
- F. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) 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.

### 3.6 POWER AND CONTROL-CIRCUIT CONDUCTORS

- A. 120-V Power Wiring: Install according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
- B. Minimum Conductor Sizes:
  - 1. Class 1 remote-control and signal circuits, No. 14 AWG.
  - 2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
  - 3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

### 3.7 CONNECTIONS

- A. Comply with requirements in Division 28 Section "Intrusion Detection" for connecting, terminating, and identifying wires and cables.
- B. Comply with requirements in Division 28 Section "Access Control" for connecting, terminating, and identifying wires and cables.
- C. Comply with requirements in Division 28 Section "Video Surveillance" for connecting, terminating, and identifying wires and cables.
- D. Comply with requirements in Division 28 Section "Digital Addressable Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

### 3.8 FIRESTOPPING

- A. Comply with requirements in Division 07 Section "Penetration Firestopping."
- B. Comply with TIA-569-B, "Firestopping" Annex A.
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

### 3.9 GROUNDING

- A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

### 3.10 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and additional requirements specified in the Division 27 Sections "Identification for Communications Systems" and color coding requirements in the section "Communications Copper Horizontal Cabling."

### 3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. UTP Cable Tests: Comply with requirements in Division 27 Section 271513 "Communication Copper Horizontal Cabling."
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports.

END OF SECTION 280513

## SECTION 280528 - PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

### PART 1 - GENERAL

#### 1.1 RELATED REQUIREMENTS

- A. Comply with requirements in section 270528 "Pathways for Communications Systems" to provide similar provisions for electronic safety and security systems cabling pathways.

### PART 2 - PRODUCTS (NOT USED)

### PART 3 - EXECUTION (NOT USED)

END OF SECTION 280528

## SECTION 281300 - ACCESS 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:

- 1. Security access controllers connected to high-speed electronic-data transmission network.
  - 2. Card readers.

- B. Related Requirements:

- 1. Section 087100 "Door Hardware".
  - 2. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cabling associated with security systems panels and devices.
  - 3. Section 281600 "Intrusion Detection" for interface/integration requirements with intrusion detection system.
  - 4. Section 275113 "Paging Systems" for interface/integration requirements with intercom and paging system for lockdown function.

#### 1.3 DEFINITIONS

- A. CCTV: Closed-circuit television.
- B. CPU: Central processing unit.
- C. Credential: Data assigned to an entity and used to identify that entity.
- D. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.
- E. GFI: Ground fault interrupter.
- F. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

- G. I/O: Input/Output.
- H. LAN: Local area network.
- I. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.
- J. PC: Personal computer. Applies to central station, workstations, and file servers.
- K. PDF: Portable Document Format. The file format used by Acrobat document-exchange-system software from Adobe,
- L. RAS: Remote access services.
- M. RF: Radio frequency.
- N. ROM: Read-only memory. ROM data are maintained through losses of power.
- O. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- P. UPS: Uninterruptible power supply.
- Q. USB: Universal serial bus.
- R. WAN: Wide area network.
- S. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- T. Windows: Operating system by Microsoft Corporation.
- U. Workstation: A PC with software that is configured for specific, limited security-system function.
- V. Central Stations: Owner's existing access control system server and monitoring software.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.
  - 1. Manufacturer's technical data for all material and equipment at the system and sub system level to be provided as part of the access control.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Indicate all system device locations on architectural floor plans. No other system(s) shall be included on these plans. New devices overlaid on existing shop drawings are acceptable.
2. Include full schematic wiring information on these drawings for all devices. Wiring information shall include cable type, conductor routings, quantities, and connection details at device including interconnectivity of door controller I/O boards, and connections to access control devices, also interconnections and to power supplies listed by Section 087100.
3. Include a complete access control one-line, block diagram.
4. Include a statement of the system sequence of operation.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. Provide items specified in Section 017823 "Operation and Maintenance Data,". Unless there are any new components not provided in the original scope, provide supplement to existing Operation and Maintenance manual.

1. As-Built Drawings: During system installation, the Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the Access Control System to be used for record drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the Access Control System. Copies of the final as-built drawings shall be provided to the end user in DXF format.

1.6 QUALITY ASSURANCE

A. Bidder Qualifications:

1. At the time of the bid, the bidder shall have satisfactorily completed projects of a similar size, scope and complexity as the system detailed in this specification. The bidder shall furnish written proof of experience from three (3) references and proof of current accreditation or certification by the manufacturer for required training for sales or installation or service of the Access Control System and associated devices.
2. The bidder shall also be a factory authorized local service organization that shall carry a complete stock of parts and provide maintenance for the Access Control System and related systems under this contract. Local shall be defined as an area in a (75) mile radius of installed location.
3. Installer Qualifications: Bidder must have personnel certified by Lenel including (1) Expert level for data base and programming (LCE), (1) Professional (LCP), and associated field installers (LCA) on staff who will perform the actual work.
4. Minimum of 5 years verifiable experience successfully completing jobs of similar nature.
5. All certified personnel to be based in Portland metro area.
6. All certifications to be provided with bid and verified by Beaverton School District.

- B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.
- 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. Comply with NFPA 70, "National Electrical Code."

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Central Station, Workstations, and Controllers:
  - 1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F (10 and 30 deg C), and not more than 80 percent relative humidity, noncondensing.
  - 2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
  - 3. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

#### 1.8 PROJECT CONDITIONS

- A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
  - 1. Control Station: Rated for continuous operation in ambient conditions of 36 to 122 deg F (2 to 50 deg C) dry bulb and a relative humidity of 20 to 90 percent, noncondensing.
  - 2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
  - 3. Outdoor Environment: NEMA 250, Type 3R enclosure. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph.

#### 1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Three years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products as follows:

1. Access Control System: Lenel Systems International Inc., no exceptions.
2. Request-to-Exit Devices: Bosch, no exceptions.
3. Door position switches: Sentrol DPDT switch or approved equal.
4. Card Readers: HID, no exceptions.

### 2.2 DESCRIPTION

A. Security Access System: The scope of this project includes access control devices to support existing access control system at the school. Not all sections may be applicable but are provided to show overall system functionality.

1. Field-installed controllers connected to an existing high-speed electronic-data transmission network and connected to existing remote PC-based central station via IP network.

### 2.3 OPERATION

A. Security access system shall use a single database for access-control and credential-creation functions.

B. Distributed Processing: A fully distributed processing system.

1. Access-control information, including time, date, valid codes, access levels, and similar data, shall be downloaded to controllers so each controller can make access-control decisions.
2. Intermediate controllers for access control are prohibited.
3. In the event that communications with the central controller are lost, controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the central station.

C. System Network Requirements:

1. System components shall be interconnected and shall provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
2. Communication shall not require operator initiation or response and shall return to normal after partial- or total-network interruption such as power loss or transient upset.
3. System shall automatically annunciate communication failures to the operator and shall identify the communications link that has experienced a partial or total failure.

D. Field equipment shall include controllers, sensors, and controls.

1. Controllers shall serve as an interface between the central station and sensors and controls.
2. Data exchange between the central station and the controllers shall include down-line transmission of commands, software, and databases to controllers.
3. The up-line data exchange from the controller to the central station shall include status data such as intrusion alarms, status reports, and entry-control records.
4. Controllers are classified as alarm-annunciation or entry-control type.

E. System Response to Alarms:

1. Field device network shall provide a system end-to-end response time of one second(s) or less for every device connected to the system.
2. Alarms shall be annunciated at the central station within one second of the alarm occurring at a controller or at a device controlled by a local controller, and within 100 ms if the alarm occurs at the central station.
3. Alarm and status changes shall be displayed within 100 ms after receipt of data by the central station.
4. All graphics shall be displayed, including graphics-generated map displays, on the console monitor within five seconds of alarm receipt at the security console.

F. False-Alarm Reduction: The design of the controllers shall contain features to reduce false alarms. Equipment and software shall comply with SIA CP-01.

G. Error Detection:

1. Use a cyclic code method to detect single- and double-bit errors, burst errors of eight bits or fewer, and at least 99 percent of all other multibit and burst errors between controllers and the central station.
2. Interactive or product error-detection codes alone will not be acceptable.
3. A message shall be in error if one bit is received incorrectly.
4. Retransmit messages with detected errors.
5. Allow for an operator-assigned two-digit decimal number to each communications link representing the number of retransmission attempts.
6. Central station shall print a communication failure alarm message when the number of consecutive retransmission attempts equals the assigned quantity.
7. Monitor the frequency of data transmission failure for display and logging.

H. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.

I. Door Hardware Interface:

1. Comply with requirements in Section 087100 "Door Hardware with Door Numbers" for door hardware required to be monitored or controlled by the security access system.
2. Electrical characteristics of controllers shall match the signal and power requirements of door hardware.

J. Integration with ShoreTel Phone and Paging System:

1. The access control system shall provide a seamless integration with school telephone system (ShoreTel) and paging system. The building lock down function shall be initiated by entering a passcode on any phone/intercom device located in the building. Provide all components and programming for a complete turnkey system.

2.4 ACCESS CONTROL POWER SUPPLIES

A. Input:

1. 120vac, 60Hz 3.5 input.

B. Output:

1. Power limited outputs.
2. 2A continuous supply current.
3. Filtered and electronically regulated.
4. Over-voltage protection.
5. 12V/24V selectable output voltage.

C. Battery Backup:

1. Built-in charger for sealed lead acid or gel type batteries.
2. Automatic switch over to stand-by battery when AC fails. Transfer to stand-by battery power is to be instantaneous with no interruption.

D. Supervision:

1. Low Power Shutdown/ Disconnect: Shuts down DC output terminals if battery voltage drops to operating voltage that can be damaging to card readers. Refer to "Low Voltage Protection and Smart Card Readers Technical Note" PLT-02604, Rev.A.1. May 2016 issued by HID Global or most current revision at time of product procurement.

E. Altronix eFlow series, or approved equivalent. Division 26 to install connection to 120V side outputs by Division 28.

2.5 POWER SUPPLIES FOR ELECTRIFIED PANIC HARDWARE

- A. Refer to Division 08 for electrified panic hardware part number. Provide power supply suitable for providing power to hardware. Von Duprin PS914, or approved equivalent, with battery backup. Size wiring from power supply to electrified panic hardware based on length of wire per manufacturer's recommendation.

## 2.6 SURGE AND TAMPER PROTECTION

- A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.
1. Provide surge protection for each 20A, 120V power circuits dedicated to access control power supplies and power supplies for electrified panic hardware fed from panels 2SB1-20,22 2SB2-11, 2SB3-9. Field verify exact number of circuits and panels. Surge protection to be provided on the primary side of the equipment as follows:
    - a. Service Voltage: 120VAC – Single phase (2W+G).
    - b. MCOV: 130V.
    - c. Protection modes: L-G, L-N, N-G.
    - d. Voltage Protection Rating: 700V L-N, L-G; 600V N-G.
    - e. Surge Current Rating: 18000A.
    - f. Ditek DTK-120HWLOK is basis of design product.
  2. Provide ACCESS CONTROL EQUIPMENT SURGE PROTECTION for the electronics as follows:
    - a. Surge Protection: Protect electronic components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.
      - 1) Provide power/signal line surge protection for wiring from access control panels/power supply to card reader. Ditek DTK-4LVLPCR or equal.
      - 2) Provide low-power disconnect module for power supplies, to prevent damage to end point devices such as card readers due in power outage conditions. Adhere to end point device manufacturer's recommendation for protection of devices and equipment. Altronix or equal. Only if adding to existing power supplies, otherwise incorporate in to original power supply.
- B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

## 2.7 CONTROLLERS

- A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the central station or workstation for controlling its operation.

- B. Subject to compliance with requirements in this article, provide controllers by Lenel Systems International Inc. Part No. LNL-2220 for intelligent dual reader controller and LNL-1320 series 2 for entry control controller.
- C. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.
- D. Entry-Control Controller:
  - 1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate and door operators, and exit push buttons.
    - a. Operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the controller and the field-device network.
    - b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:
      - 1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
      - 2) Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control.
    - c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
  - 2. Inputs:
    - a. Data from entry-control devices; use this input to change modes between access and secure.
    - b. Database downloads and updates from the central station that include enrollment and privilege information.
  - 3. Outputs:
    - a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
    - b. Grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries.
    - c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the central station.

- d. Door Prop Alarm: If a portal is held open for longer than 20 seconds, alarm sounds.
- 4. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
- 5. Data Line Problems: For periods of loss of communication with the central station, or when data transmission is degraded and generating continuous checksum errors, the controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.
  - a. Store up to 1,000 transactions during periods of communication loss between the controller and access-control devices for subsequent upload to the central station on restoration of communication.
- 6. Controller Power: NFPA 70, Class II power-supply transformer, with 12- or 24-V ac secondary, backup battery and charger.
  - a. Backup Battery: Valve-regulated, recombinant-sealed, lead-acid battery; spill proof. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
  - b. Backup Power-Supply Capacity: 90 minutes of battery supply. Submit battery and charger calculations.
  - c. Power Monitoring: Provide manual, dynamic battery-load test, initiated and monitored at the control center; with automatic disconnection of the controller when battery voltage drops below controller limits. Report by using local controller-mounted digital displays and by communicating status to central station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:
    - 1) Trouble Alarm: Normal power-off load assumed by battery.
    - 2) Trouble Alarm: Low battery.
    - 3) Alarm: Power off.

## 2.8 CARD READERS

- A. Card-Reader Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.
- B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.
- C. Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:
  - 1. Indoors, controlled environment.

2. Indoors, uncontrolled environment.
  3. Outdoors, with operating temperature range as needed for operation at the site. Provide with 16-gauge steel shroud; Model Hood-CS-4.5x6 or approved equal.
- D. Display: Digital visual indicator shall provide visible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.
- E. Proximity Readers:
1. The card reader shall read proximity cards in a range from direct contact up to 5 inches from the reader.
  2. Interior Readers: HID.
  3. Exterior Readers: HID.
  4. Mullion Readers: HID.
  5. Proximity Cards: iClass cards provided by the Owner.
- F. Communication Protocol: Compatible with local processor and HID-200PGGMN iClass proximity credential cards.

## 2.9 DOOR AND GATE HARDWARE INTERFACE

- A. Exit Alarm: Operation of a monitored door shall generate an alarm. Request to Exit devices are integrated with door locks at some locations and are specified in Section 087100 "Door Hardware." Provide motion sensor type Request to Exit devices at all other locations as indicated on the drawings. Alarm contacts (Door Position Switches) are specified in Section 281600 "Intrusion Detection."
- B. Electric Door Strikes: End-of-line resistors shall provide power-line supervision. Signal switches shall transmit data to controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and they shall report a forced entry. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the controller. Electric strikes are specified in Section 087100 "Door Hardware with Door Numbers."

## 2.10 BACKBOARDS

- A. Provide backboards for mounting access control panels and door power supplies:
1. A/C grade plywood, fire-rated plywood.
  2. ¾ by 48 by 96 inch sheets.

## 2.11 ADA OPERATOR INTERFACE

- A. Provide interface to ADA operators and controls specified by Division 08, include relays and timer modules to provide functionality indicated in details on Drawings.

## 2.12 TIA 232-F ASCII INTERFACE SPECIFICATIONS

### A. Alarm-System Interface:

1. TIA 232-F output shall be capable of transmitting alarms from other monitoring and alarm systems to central-station automation software.
2. Alternatively, alarms that are received by this access-control system are to be transferred to the alarm automation system as if they were sent through a digital alarm receiver.
  - a. System shall be able to transmit an individual message from any alarm input to a burglar-alarm automation monitoring system.
  - b. System shall be able to append to each message a predefined set of character strings as a prefix and a suffix.

## 2.13 CABLES

### A. General Cable Requirements: Comply with requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security" and as recommended by system manufacturer for integration requirement.

### B. Plenum-Type, TIA 485-A Cables:

1. Two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

### C. Multiconductor, Plenum-Type, Reader and Wiegand Keypad Cables:

1. Six conductors, No. 20 AWG, stranded (7x28) tinned copper conductors, fluorinated-ethylene-propylene insulation, overall aluminum-foil/polypropylene-tape shielded with 100 percent shield coverage plus tinned copper braid shield with 85 percent shield coverage, and fluorinated-ethylene-propylene jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

### D. Paired, Plenum-Type, Lock Cables:

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

### E. Paired, Plenum-Type, Lock Cables:

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.

2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

F. Paired, Plenum-Type, Input Cables:

1. One pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, aluminum-foil/polyester-tape shield (foil side out), with No. 22 AWG drain wire, 100 percent shield coverage, and plastic jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

G. Paired, Plenum-Type, AC Transformer Cables:

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

H. LAN Cabling:

1. Comply with requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."
2. NFPA 262.
3. Category 6 four-pair UTP cable, plenum-rated.
4. 8-position Category 6 modular jacks.
5. Panduit. General, Commscope/ Systimax or approved.

I. Wire and cable from access control panel location out to door devices to be in a combined in an overall cable jacket.

J. Patch cords – Pink.

## 2.14 TRANSFORMERS

- A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

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- B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Comply with recommendations in SIA CP-01.
- B. Comply with TIA/EIA 606-A, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.
  - 1. For each Location, record setup of controller features and access requirements.
  - 2. Propose start and stop times for time zones and holidays, and match up access levels for doors.
  - 3. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
  - 4. Assign action message names and compose messages.
  - 5. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
  - 6. Prepare and install alarm graphic maps.
  - 7. Develop screen layout formats.
  - 8. Complete system diagnostics and operation verification.
  - 9. Prepare a specific plan for testing, startup, and demonstration.
  - 10. Develop acceptance test concept and, on approval, develop specifics of the test.
- D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.
- E. The District will provide network switches; security devices are networked on a dedicated District security VLAN. The District standard for network switching equipment is Brocade.
- F. Contractor is required to submit a list of IP devices requiring IP addresses and associated information required for programming purposes, in a spreadsheet or table format, such that District IT staff can provide all necessary information in a timely manner with minimal effort. Indicate whether devices require Power-over-Ethernet.

### 3.3 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

- B. Install cables and wiring according to requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
- E. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and fiber-optic rating of components, and that ensure Category 6 and fiber-optic performance of completed and linked signal paths, end to end.
- F. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
- G. Do not install new access control wire and cable into the same conduit or wireway occupied by fire alarm, paging/intercom, or clock system wiring.

### 3.4 CABLE APPLICATION

- A. Comply with TIA 569-B, "Commercial Building Standard for Telecommunications Pathways and Spaces."
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. (1220 m).
- D. Card Readers and Keypads:
  - 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
  - 2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft. (75 m), and install No. 20 AWG wire if maximum distance is 500 ft. (150 m).
  - 3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
  - 4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

- E. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft. (75 m).
- F. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft. (8 m).

### 3.5 GROUNDING

- A. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."
- B. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- C. Bond shields and drain conductors to ground at only one point in each circuit.
- D. Signal Ground:
  - 1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
  - 2. Bus: Mount on wall of main equipment room with standoff insulators.
  - 3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

### 3.6 INSTALLATION

- A. Install card readers, keypads and push buttons.
- B. Integrate access control system with the following systems and equipment:
  - 1. Electronic door hardware.
  - 2. Shoretel phone and paging systems.
  - 3. Intrusion detection system.

### 3.7 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 260553 "Identification for Electrical Systems" and with TIA/EIA 606-A.
- B. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
  - 1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.

2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

C. At completion, cable and asset management software shall reflect as-built conditions.

### 3.8 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. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-B.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-B.1.
2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

### 3.9 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."
- B. Develop separate training modules for the following:
  - 1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
  - 2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
  - 3. Security personnel.
  - 4. Hardware maintenance personnel.
  - 5. Corporate management.

END OF SECTION 281300

## SECTION 281600 - INTRUSION DETECTION

### 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. Complete coverage intrusion detection with communication links to perform monitoring, alarm, and control functions.
  - 2. Integration of other electronic and electrical systems and equipment.

- B. Related Sections:

- 1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cabling between master control units and field-mounted devices and control units.
  - 2. Section 281300 "Access Control" for interface/integration requirements with access control system.
  - 3. Section 282300 "Video Surveillance" for interface/integration requirements with IP video cameras.

#### 1.3 DEFINITIONS

- A. PIR: Passive infrared.
- B. RFI: Radio-frequency interference.
- C. UPS: Uninterruptible power supply.
- D. Control Unit: System component that monitors inputs and controls outputs through various circuits.
- E. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.
- F. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

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- G. Protected Zone: A protected premises or an area within a protected premise that is provided with means to prevent an unwanted event.
- H. Standard Intruder: A person who weighs 100 lb (45 kg) or less and whose height is 60 inches (1525 mm) or less; dressed in a long-sleeved shirt, slacks, and shoes.
- I. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.
- J. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
- K. Zone. A defined area within a protected premise. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: Components for sensing, detecting, systems integration, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.
  - 1. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify control interface devices and media to be used. Describe characteristics of network and other data communication lines.
    - a. Indicate methods used to achieve systems integration.
    - b. Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
    - c. Describe characteristics of network and other data communication lines.
    - d. Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.
  - 2. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection and for systems integration. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
  - 3. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building.
  - 4. Master Control-Unit Console Layout: Show required artwork and device identification.
  - 5. Device Address List: Coordinate with final system programming.

6. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
  7. Details of surge-protection devices and their installation.
  8. Sensor detection patterns and adjustment ranges.
- C. Equipment and System Operation Description: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.
- C. Warranty: Sample of special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  1. Data for each type of product, including features and operating sequences, both automatic and manual.
  2. Master control-unit hardware and software data.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
  1. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project. Installer must be Bosch Certified.
- 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. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.
- D. FM Global Compliance: FM-Approved and -labeled intrusion detection devices and equipment.
- E. Comply with NFPA 70.

## 1.8 PROJECT CONDITIONS

- A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Altitude: Sea level to 4000 feet (1220 m).
  2. Central-Station Control Unit: Rated for continuous operation in an ambient of 60 to 85 deg F (16 to 29 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
  3. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambients of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.

## 1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Three years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. Description: Hard-wired, modular, microprocessor-based controls, Full (complete) coverage intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.
- B. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.
1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
  2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
  3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.
- C. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.

- D. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.
- E. Operator Commands:
  - 1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
  - 2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
  - 3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
  - 4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
  - 5. Protected Zone Test: Initiate operational test of a specific protected zone.
  - 6. System Test: Initiate system-wide operational test.
  - 7. Print reports.
- F. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.
- G. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.
- H. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.
- I. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.

## 2.2 SYSTEM COMPONENT REQUIREMENTS

- A. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit shall be selected and configured with accessories for full compatibility with the following equipment:
  - 1. Door hardware specified in Section 087100 "Door Hardware with Door Numbers."
  - 2. Access control system specified in Section 281300 "Access Control."
  - 3. System must be compatible with "ADT" remote monitoring service provider.

- B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
  - 1. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.
- C. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.
- D. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.
- E. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.
- F. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.

## 2.3 ENCLOSURES

- A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.
- B. Interior Electronics: NEMA 250, Type 12.
- C. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

## 2.4 SECURE AND ACCESS DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by Bosch Security Systems, Inc.
- B. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

## 2.5 DOOR AND WINDOW SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Bosch Security Systems, Inc. Model; ISN-CTC75

2. Inerlogix United Technologies. Model; 1078/1076 series

- B. Description: Double Pole Double Throw DPDT, Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of two encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.
- C. Flush-Mounted Switches: Unobtrusive and flush with surface of door and window frame.

2.6 PIR TECHNOLOGY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products Bosch Security Systems, Inc.
  - 1. PIR Detector Model ISC-PPR1-W16
- B. Description: PIR detector designed for commercial indoor applications. The unit shall consist of a self-locking two-piece enclosure with a built in two-way bubble level to help simplify the installation. The detector shall incorporate 1) sensor data fusion technology to ensure that the detector sends alarm conditions based only on precise information and 2) tri-focus optics technology to eliminate coverage gaps.
- C. Listed and labeled by a qualified testing agency for compliance with the following standards and approvals:
  - 1. UL 639 and cULus
  - 2. CE
  - 3. C-Tick
  - 4. EN50131-1 Grade 2
- D. Device Performance: An alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.
  - 1. The detector specified shall provide active white light suppression capable of measuring the light intensity directed at the face of the unit and use the data gathered by the sensors to eliminate false alarms caused by the bright light source. False alarms shall not be caused from bright light sources up to 10,000 lux.
  - 2. The detector shall provide the following DIP switch selectable fields of coverage:
    - a. 16 m x 21 m (50 ft x 70 ft)
    - b. 8 m x 10 m (26 ft x 33 ft)
  - 3. The detector shall be designed to be mounted at a height between 2.1 m to 3m (7 ft to 10 ft) and require no adjustments.
  - 4. The detector shall provide dynamic temperature compensation that adjusts the PIR sensitivity to identify human body heat accurately at critical temperatures to avoid false alarms and deliver consistent catch performance at all operating temperatures.

5. The detector shall provide a cover and wall tamper switch with a normally- closed contact that opens to notify the control panel in the event the cover is removed or the detector is separated from the wall. The contacts shall be rated at 25 VDC, 125 mA maximum.
  6. The detector shall contain a blue light emitting diode (LED) that adjusts automatically to the surrounding light level. The LED indicates alarms, and will activate during a walk test.
  7. The walk test LED may be enabled or disabled via a command from the control panel, or, it may be enabled or disabled using the local DIP switch of the detector.
  8. The detector shall provide a solid state relay that is power supervised and uses less current and provides longer standby capacity than a mechanical relay. The solid state relay shall be used to send a silent alarm output signal. Rating of the relay shall be 3W, 125 mA, 25 VDC, with resistance less than 10 ohms.
  9. The detector shall reduce false alarms by having a sealed optic chamber that provides immunity to drafts and insects.
- E. Mounting Brackets: The manufacturer shall offer the following three optional mounting brackets.
1. A Gimbal-mount bracket Bosch B328 hat mounts on a single-gang box and allows rotation of the detector.
  2. A low profile plastic wall swivel mount bracket Bosch B335-3 The mount allows a vertical pivot range of +10° to -20° and a horizontal pivot range of ±25°.
  3. A plastic universal swivel bracket for ceiling mounting Bosch B338 The mount allows a vertical pivot range of +7° to -16° and a horizontal pivot of ±45°.

## 2.7 AUDIBLE AND VISUAL ALARM 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. Alarm Controls Corporation.
  2. Cooper Wheelock.
  3. Edwards Signaling & Security Systems; part of GE Security.
  4. Honeywell International Inc.; Honeywell Security.
  5. Potter Electric Signal, LLC.
- B. Siren: 30-W speaker with siren driver, rated to produce a minimum sound output of 103 dB at 10 feet (3 m) from master control unit.
1. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.
- C. Strobe: Xenon light complying with UL 1638, with a clear polycarbonate lens.
1. Light Output: 115 cd, minimum.
  2. Flash Rate: 60 per minute.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.
- D. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.
  - 1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
  - 2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.
- E. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 SYSTEM INTEGRATION

- A. Integrate intrusion detection system with the following systems and equipment:
  - 1. Electronic door hardware.
  - 2. Access control.
  - 3. Lighting Controls.

### 3.3 SYSTEM INSTALLATION

- A. Comply with UL 681 and NFPA 731.
- B. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
  - 1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

### 3.4 WIRING INSTALLATION

- A. Wiring Method: Install wiring in metal raceways according to Section 260533 "Raceways and Boxes for Electrical Systems." Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.
- B. Wiring Method: Install wiring in metal raceways according to Section 260533 "Raceways and Boxes for Electrical Systems," except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.
- C. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- E. Wires and Cables:
  - 1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
  - 2. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
  - 3. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 280513 "Conductors and Cables for Electronic Safety and Security."
  - 4. Data and Television Signal Transmission Cables: Install according to Section 280513 "Conductors and Cables for Electronic Safety and Security."
- F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- G. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.
- H. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

### 3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 260553 "Identification for Electrical Systems."
- B. Install instructions frame in a location visible from master control unit.

### 3.6 GROUNDING

- A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.
- B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.

### 3.7 FIELD QUALITY CONTROL

- A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
  - 1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."
  - 1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
  - 2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."
- D. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."

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- E. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

### 3.8 ADJUSTING

- 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. Visits for this purpose shall be in addition to any required by warranty.

### 3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

END OF SECTION 281600

## SECTION 282300 - VIDEO SURVEILLANCE

### 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. Video surveillance system shall be integrated with monitoring and control system specified in Section 281600 "Intrusion Detection," and Section 281300 "Access Control," which specifies systems integration.

#### 1.3 DEFINITIONS

- A. AGC: Automatic gain control.
- B. CCD: Charge-coupled device.
- C. FTP: File transfer protocol.
- D. IP: Internet protocol.
- E. LAN: Local area network.
- F. MPEG: Moving picture experts group.
- G. NTSC: National Television System Committee.
- H. PC: Personal computer.
- I. PTZ: Pan-tilt-zoom.
- J. RAID: Redundant array of independent disks.
- K. TCP: Transmission control protocol - connects hosts on the Internet.
- L. UPS: Uninterruptible power supply.
- M. WAN: Wide area network.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Video surveillance system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
  - 3. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
  - 4. Wiring Diagrams: For power, signal, and control wiring.
- C. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For video surveillance, cameras, camera-supporting equipment, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

- C. Warranty: Sample of special warranty.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

#### 1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NECA 1.
- C. Comply with NFPA 70.
- D. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

#### 1.9 PROJECT CONDITIONS

- A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Control Station: Rated for continuous operation in ambient temperatures of 60 to 85 deg F (16 to 29 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
  2. Interior, Controlled Environment: System components, except central-station control unit, installed in air-conditioned interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
  3. Interior, Uncontrolled Environment: System components installed in non-air-conditioned interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F (minus 18 to plus 50 deg C dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 3R enclosures.
  4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h). Use NEMA 250, Type 3R enclosures.

5. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

#### 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 SYSTEM REQUIREMENTS

- A. The cameras shall be IP based network type providing a 100Base-TX network interface for live streaming to a standard Web browser.
- B. Network cameras shall support standard IT protocols.
- C. The network camera shall support industry standard Power over Ethernet (PoE), IEEE 802.3af to supply power to the camera over the network.
- D. The network camera shall offer a video output port providing an NTSC/PAL analog video output signal for adjusting the field of view and when focusing the camera.
- E. Appliance based recording with network management capabilities.
- F. Appliance based recorder to be located at local site of interest.
- G. Software client must have ability for local viewing of camera and viewing from the District at any given location within the District network base.

#### 2.2 REINFORCED DOME IP CAMERAS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Arecont Vision; MegaDome® 2 IP Megapixel Cameras or comparable product by one of the following:
  1. Samsung/ Hanwha
- B. Exterior Locations: MegaDome ® 2 AV10255PMIR-SH: 10 Megapixel H.265 IP camera with 4.7-9mm Remote Zoom, Remote Focus and P-Iris Lens, SDHC Card and IR LEDs
  1. 10-Megapixel/1080p dual mode network camera.

2. Fully H.265 IP (MPEG-4, Part 10) compliant, provides full 3648 x 2752 megapixel resolution at full video frame rates of 7 frames per second (fps) at 10-megapixel and 29fps in 1080p binned mode.
3. An all-in-one solution with integrated 10-megapixel day/night camera, remote focus, remote zoom, auto-iris lens (AM model) or P-Iris (PM model), 4.7-9mm (AM model), 4-10mm (PM model) or 12-22mm (PMT model) lens options, SDHC card (-S model), scaling.
4. IP66 water/dust ingress rating and vandal resistant dome enclosure IK-10 rating.
5. Electrical Power
  - a. General purpose opto-coupled input and output
  - b. Power over Ethernet (PoE): PoE 802.3af
  - c. Auxiliary Power 12-48V DC, 24VAC
  - d. Power consumption: PoE – Class 3
6. Built-in IR illuminator (-IR Model)
  - a. 24 pcs 850nm LEDs / 50ft (15m) IR distance (max) / 40° IR angle (PMIR Model)
  - b. 24 pcs 850nm LEDs / 120ft (36m) IR distance (max) / 30° IR angle (PMTIR Model)
  - c. Total PoE Solution (No external power requirement)
7. Built-in Heater Option
  - a. Power Output: 2.28 W Max
  - b. Switch: On: 4C° (32.9 °F), Off: 6.5 °C (43.7 °F)
  - c. Total PoE Solution: No external power requirement
8. Lens included.

## 2.3 POWER SUPPLIES

- A. All cameras and housing blower heaters shall be powered over Ethernet PoE.

## 2.4 CAMERA-SUPPORTING EQUIPMENT

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  1. Samsung/ Hanwha
- B. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.
- C. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.

## VIDEO SURVEILLANCE

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- D. Protective Housings for Fixed and Movable Cameras: Steel or 6061 T6 aluminum enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.
1. Camera Viewing Window: Polycarbonate window, aligned with camera lens.
  2. Alignment Provisions: Camera mounting shall provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
  3. Built-in, thermostat-activated heater and blower units. Units shall be automatically controlled so the environmental limits of the camera equipment are not exceeded.
  4. Sun shield shall not interfere with normal airflow around the housing.
  5. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket shall be of same material as the housing; mounting hardware shall be stainless steel.
  6. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.
  7. Enclosure Rating: NEMA 250, Type 3R.

## 2.5 PoE NETWORK SWITCHES

- A. PoE network switches shall be owner furnished, contractor installed. Contractor shall provide the basic requirements and a count for the total number of network switches required.

## 2.6 SIGNAL TRANSMISSION COMPONENTS

- A. Cable: Comply with requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security" and Section 271513 "Communications Copper Horizontal Cabling."

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN, WAN, and IP network before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 WIRING

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."
- B. Wiring Method: Install cables in raceways unless otherwise indicated.

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1. Except raceways are not required in accessible indoor ceiling spaces and attics.
  2. Except raceways are not required in hollow gypsum board partitions.
  3. Conceal raceways and wiring except in unfinished spaces.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. 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.
- E. For LAN connection and copper communication wiring, comply with Section 271513 "Communications Copper Horizontal Cabling."
- F. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

### 3.3 VIDEO SURVEILLANCE SYSTEM INSTALLATION

- A. Install cameras and infrared illuminators level and plumb.
- B. Install cameras with 84-inch- (2134-mm-) minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.
- C. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.
- D. Install power supplies and other auxiliary components at control stations unless otherwise indicated.
- E. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.
- F. Identify system components, wiring, cabling, and terminals according to Section 260553 "Identification for Electrical Systems."
- G. Install and configure video management software on owner furnished base server and any work stations.

### 3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
  - a. Prepare equipment list described in "Informational Submittals" Article.
  - b. Verify operation of auto-iris lenses.
  - c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
  - d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
  - e. Set and name all preset positions; consult Owner's personnel.
  - f. Set sensitivity of motion detection.
  - g. Connect and verify responses to alarms.
  - h. Verify operation of control-station equipment.
3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

C. Video surveillance system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

### 3.5 ADJUSTING

- 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 two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:
  1. Check cable connections.

2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
3. Adjust all preset positions; consult Owner's personnel.
4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
5. Provide a written report of adjustments and recommendations.

### 3.6 CLEANING

- A. Clean installed items using methods and materials recommended in writing by manufacturer.
- B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

### 3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

END OF SECTION 282300

## SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

### 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. Manual fire-alarm boxes.
  - 2. System smoke detectors.
  - 3. Heat detectors.
  - 4. Notification appliances.
  - 5. Magnetic door holders.
  - 6. Remote annunciator.
  - 7. Addressable interface device.
  - 8. Digital alarm communicator transmitter.

#### 1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

#### 1.4 SYSTEM DESCRIPTION

- A. All new equipment to be integrated into the existing Fire Alarm System. Not all sections may be applicable but are provided to show overall system functionality.
- B. Detectors and control devices shall be addressable only using dipswitches.

#### 1.5 PERFORMANCE REQUIREMENTS/ OPERATION

- A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

## 1.6 SUBMITTALS

### A. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
  - a. Trained and certified by manufacturer in fire-alarm system design.
  - b. NICET-certified fire-alarm technician, Level III minimum.
  - c. Licensed or certified by authorities having jurisdiction.

## 1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Field quality-control reports.

## 1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. Provide items specified in Section 017823 "Operation and Maintenance Data,". Unless there are any new components not provided in the original scope, provide supplement to existing Operation and Maintenance manual.

## 1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
- C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer.
- 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. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.

1.10 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. SIMPLEXGRINNELL, no substitutions.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems as required to meet current building code requirements and satisfy AHJ fire code requirements:
  - 1. Manual stations.
  - 2. Heat detectors.
  - 3. Smoke detectors.
  - 4. Duct smoke detectors.
  - 5. Automatic sprinkler system water flow.
- B. Fire-alarm signal shall initiate the following actions:
  - 1. Continuously operate alarm notification appliances.
  - 2. Identify alarm at fire-alarm control unit and remote annunciators.
  - 3. Transmit an alarm signal to the remote alarm receiving station.
  - 4. Release fire and smoke doors held open by magnetic door holders.
  - 5. Activate emergency shutoffs for gas and fuel supplies.
  - 6. Record events in the system memory.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
  - 1. Valve supervisory switch.
  - 2. Low-air-pressure switch of a dry-pipe sprinkler system.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
  - 1. Open circuits, shorts, and grounds in designated circuits.

2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.
9. Low-air-pressure switch operation on a dry-pipe or pre-action sprinkler system.

- E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators.

## 2.3 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
  2. Station Reset: Key- or wrench-operated switch.
  3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm, with sounder. (Model STI-1100-G)

## 2.4 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
1. Comply with UL 268; operating at 24-V dc, nominal.
  2. Detectors shall be four-wire type.
  3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
  4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
  5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
  6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
- B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
  - a. Primary status.
  - b. Device type.
  - c. Present average value.
  - d. Present sensitivity selected.
  - e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
  - a. Primary status.
  - b. Device type.
  - c. Present average value.
  - d. Present sensitivity selected.
  - e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector or SimplexGrinnell Weatherproof Duct Housing Enclosure 4098-9845 as required.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

## 2.5 PROJECTED BEAM SMOKE DETECTORS

- A. Projected Beam Light Source and Receiver: Designed to accommodate small angular movements and continue to operate and not cause nuisance alarms.
- B. Detector Address: Accessible from fire-alarm control unit and able to identify the detector's location within the system and its sensitivity setting.
- C. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
  1. Primary status.
  2. Device type.
  3. Present average value.
  4. Present sensitivity selected.

5. Sensor range (normal, dirty, etc.).

## 2.6 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector or Weatherproof based on environmental considerations: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
  1. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).
  1. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

## 2.7 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned or addressable based on system capability, equipped for mounting as indicated and with screw terminals for system connections. (White with Red Letter Devices Required for this project.)
  1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
- B. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the device in red.
  1. Rated Light Output:
    - a. 15/30/75/110 cd, candela settings to be set at the panel for each device as require.
  2. Mounting: Wall mounted unless otherwise indicated.
  3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
  4. Flashing shall be in a temporal pattern, synchronized with other units.
  5. Strobe Leads: Factory connected to screw terminals.
  6. Mounting Faceplate: Factory finished, white.
- C. Voice/Tone Notification Appliances:

1. Comply with UL 1480.
2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
3. High-Range Units: Rated 2 to 15 W.
4. Low-Range Units: Rated 1 to 2 W.
5. Mounting: Flush.
6. Matching Transformers: Tap range matched to acoustical environment of speaker location.

## 2.8 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
  1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
  2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
  3. Rating: 24-V ac or dc.
- B. Material and Finish: Match door hardware.
- C. Lockdown doors to be equipped with relay in order to release doors in the event of a fire alarm event.

## PART 3 - EXECUTION

### 3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
  1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
- C. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- D. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- E. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling.

- F. Device Location-Indicating Lights: Locate in public space near the device they monitor.

### 3.2 CONNECTIONS

- A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet (1 m) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
1. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
  2. Supervisory connections at valve supervisory switches.
  3. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.

### 3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.
- C. Provide label devices as follows:
1. Initiating Devices (Circuit ID – Device Number) (M### - ##).
  2. Notification Devices (Panel ID – NAC Circuit Number – Device Number) (P### - N## - ##).
  3. Junction and Pull Boxes: legibly write on the cover with indelible ink pen the circuits contained in each box. Covers for all boxes containing fire alarm circuits shall be painted red.

### 3.4 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

### 3.5 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
1. Visual Inspection: Conduct visual inspection prior to testing.
    - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents,

Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.

- b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
- 2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
- 3. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
- C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- D. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.
- B. Provide End-User Training.

END OF SECTION 283111

## SECTION 312300 - EARTHWORK

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SECTION INCLUDES

- A. Excavation, compaction and backfill.
- B. Trench excavation, bedding and backfill.

#### 1.3 RELATED DOCUMENTS

- A. 312513 - Erosion Control

#### 1.4 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation and backfill work in compliance with applicable requirements of governing authorities having jurisdiction.
- B. Soil Testing Service:
  - 1. The Owner will engage a soil testing service, to include testing soil materials proposed for use in the work and for quality control testing during excavation and fill operations.
  - 2. Samples of materials shall be furnished to the testing service by the Contractor.
  - 3. Under this Contract, the Contractor shall smooth out areas for density tests and otherwise facilitate testing work as directed.

#### 1.5 SUBMITTALS

- A. For information, submit description of dewatering methods proposed for use.
- B. For information, submit description of vibratory compactors proposed for use when requesting placement of backfill and fill materials greater than requirement established herein.
- C. Materials for use as "imported fill material", and "pipe bedding and backfill material".

1.6 PROJECT CONDITIONS

- A. Site information: Subsurface conditions were investigated by GeoDesign Inc., 9450 SW Commerce Circle, Suite 300, Wilsonville OR 97070, Dated December 14, 2015. Samples, logs and other data may be inspected by contacting them.
1. The data on subsurface conditions are not intended as representations or warranties or accuracy or continuity of such conditions between soil borings. It is expressly understood the Owner will not be responsible for interpretations or conclusions drawn there from by the Contractor. The data is made available for the convenience of the Contractor.
  2. Additional test borings and other exploratory operations may be made by the Contractor at no additional cost to the Owner.
- B. Disposal of Waste Material:
1. Disposal sites for earth waste materials are not available on Owner's property. Materials that are not suitable for use as topsoil or cannot be used in embankments or construction shall be disposed off-site.
  2. Contractor shall restrict temporary storage of waste materials and materials to be reused to the designated work areas.
  3. Contractor shall arrange and pay for removal and disposal of all waste materials encountered in the work.
- C. Existing Utilities:
1. Locate existing underground utilities in the areas of work. If utilities are to remain in place, provide adequate means of protection during excavation operations.
  2. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with the Owner and public and private utility companies in keeping their respective services and facilities in operation. Repair damaged utilities to the satisfaction of the utility owner.
  3. Do not interrupt existing utilities serving facilities occupied and used by the Owner or others, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.
  4. Demolish and completely remove from the site existing underground utilities which are not to remain in service and are located within an excavation area. Coordinate with local utility companies for shut-off services in lines that are active.
- D. Barricade open excavations in compliance with code requirements. Protect structures, utilities, sidewalks, pavement, and other facilities immediately adjacent to excavations, from damages caused by settlement, lateral movement, undermining, washout and other hazards.
- E. Protection of Subgrade: Do not allow equipment to disturb subgrade, stripped areas, or other areas prepared for project. Prevent water from collecting on surface. Repair disturbed subgrade as specified below for unauthorized excavation.

- F. Excavation Safety: The Contractor shall be solely responsible for making all excavations in a safe manner. Provide appropriate measures to retain excavation side slopes and prevent rock falls to ensure that persons working in or near the excavation are protected.
- G. Protection:
  - 1. Protect trees and other features remaining as a portion of the final landscaping.
  - 2. Protect bench marks, utilities, sidewalks, paving and curbs from equipment, vehicular traffic and general construction activities.
  - 3. Protect above and below grade utilities which are to remain.
  - 4. Cover and protect stockpiled materials as shown on the drawings.
  - 5. Notify Engineer of unexpected subsurface conditions and discontinue affected work in the area until notified to resume operations.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. OSHD Specification refers to the State of Oregon Highway Division, Standard Specifications for Highway Construction.
- B. Topsoil: Top soil for use in preparing landscape or lawn areas will be as specified and approved by the project Landscape Architect. See landscape specifications for materials and depths.
- C. Stripping: Grass, sod and other types of vegetation removed.
- D. Compacted Fill: Any on-site soil materials free of organic matter, non-plastic (dried), containing no particles larger than 4 inches, capable of compaction as specified, and approved by the soil testing service. Use for trench zone and trench foundation stabilization material in all areas not receiving improvements. Material shall be approved by the soil testing service prior to use in the Work.
- E. Imported Fine-Grained Material: Material approved by the soil testing service for use as embankment material from an off-site source other than imported granular material. The source shall be approved by the soil testing agency prior to use.
- F. Select Granular Fill: Imported granular fill materials should consist of sand, gravel or fragmental rock with a maximum particle size of 6 inches and with not more than 5% passing the #200 sieve (washed analysis).

- G. Pipe Bedding and Backfill Material: Crushed rock with a maximum particle size of 3/4" capable of compaction as specified, with not more than 10% passing the #200 sieve (washed analysis) zone and should meet the requirements set forth by ODOT SS 00405.13 (Pipe Zone Material). Backfill Material with maximum particle size of 2 1/2" and no more than 10% passing the #200 sieve should meet the requirements set forth by ODOT SS 0405.14 (Trench Backfill, Class B, C, or D). Material shall be approved by the soil testing service prior to use in the Work.
- H. Trench Stabilization Material: Trench stabilization material shall consist of quarry run rock, crushed rock, or crushed gravel and sand and shall meet the requirements set forth by ODOT SS 00330.14 and 00330.15, with a minimum particle size of 6 inches and less than 5 percent passing the U.S. Standard No. 4 Sieve. The material shall be free of organic matter and other deleterious material. Trench stabilization material shall be placed in one life and compacted to a firm condition.
- I. Free Draining Fill: Free-draining material for blanket or wall drains for the subdrainage system shall be crushed rock of 1 1/2"-3/4" gradation with not more than 2% passing the #200 sieve (washed analysis).
- J. Drain Rock: Drain rock should consist of angular, granular material with a gradation of 2" and should meet the requirements set forth by ODOT SS 00430.11 (Granular Drain Backfill Material). The material should be free on roots, organic matter, and other unsuitable material, have less than 2% passing the #200 sieve, and have two mechanically fractured faces.

### PART 3 - EXECUTION

#### 3.1 SITE CLEARING

- A. General: The Contractor shall clear the staked or indicated area of all objectionable materials. This includes the removal of vegetation, top-soil, improvements, or obstructions interfering with installation of new construction unless otherwise indicated as protected. Remove such items off of the property and dispose of properly.
- B. Clearing and Grubbing:
  - 1. In areas designated to be cleared and grubbed, all stumps, roots, buried logs, brush, grass and other unsatisfactory materials shall be removed, except where embankments exceeding 3-1/2 feet in depth are to be made outside of paved areas or where structures are to be placed. In cases where such depth of embankments is to be made, all unsatisfactory materials shall be removed, but sound trees, stumps and brush can be cut off within 6 inches above the ground and allowed to remain. Tap roots and other projections over 1 1/2 inch in diameter shall be grubbed out to a depth of at least 18 inches below the finished subgrade of slope elevation.
  - 2. All holes remaining after the grubbing operation in embankment areas shall have the sides broken down to flatten out the slopes, and shall be filled with acceptable material,

moistened and properly compacted in layers to the required density. The same construction procedure shall be applied to all holes remaining after grubbing in excavation areas where the depth of holes exceeds the depth of the proposed excavation.

3. Trees unavoidably falling outside the specified limits must be cut up, removed and disposed of in a satisfactory manner. In order to minimize damage to trees that are to be left standing, trees shall be felled toward the center of the area being cleared. The Contractor shall preserve and protect from injury all trees not to be removed.

- C. Stripping: Strip all organic matter under areas to receive pavement, sidewalks and building pads. Approximate stripping depth is 3-4 inches. There could be areas that may require removal between 5-12 inches. The geotechnical engineer or testing agency, shall observe the stripping depths to ensure adequate material has been removed.

### 3.2 EXCAVATIONS

- A. Excavation consists of removal and disposal of all material encountered when establishing required grade elevations. All excavation is unclassified. The contours indicated on the drawings indicate finish grade unless otherwise indicated and the Contractor shall provide for the minimum depth of topsoil. Finish grading and soil preparation is covered in landscaping specifications.
- B. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer. Unauthorized excavation, as well as remedial work directed by the Engineer, shall be at no change in Contract amount.
- C. Additional Excavation: When excavation has reached required subgrade or trench invert elevations, notify the soil testing service who will observe conditions.
  1. Proof roll ground surface. Proof rolling will be observed by the testing service. Remove soft areas detected by the proof rolling and replace with compacted fill or imported fill material as directed.
  2. If unsuitable bearing materials are encountered at the required subgrade elevations, carry excavations deeper and replace the excavated material as directed.
- A. Stability of Excavations: The stability of excavation slopes will be the responsibility of the Contractor in conformance with the recommendations of the geotechnical investigation.
- B. Unbraced Slopes: Any excavations deeper than 4 feet in height should be sloped or shored in accordance with Occupational Safety and Health Association (OSHA) regulations. Finished slopes shall be no steeper than 2H:1V.
- C. Shoring and Bracing: Provide shoring and bracing to comply with local codes and authorities having jurisdiction. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of the time period excavations will be open. Carry down shoring and bracing as the excavation progresses.

- D. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding the project site and surrounding area.
1. Do not allow water to accumulate in excavations. Remove water to prevent detrimental soil changes to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines and other dewatering system components necessary to convey water away from excavations.
  2. Convey water removed from excavations and rain water to collection or run-off areas. Establish and maintain temporary drainage ditches and other diversions outside excavation limits for each structure. Do not use trench excavations as temporary drainage ditches.
  3. Provide treatment of the water in order to comply with the erosion control permit for the project.
- E. Excavation for Building Pads:
1. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10', and extend a sufficient distance from footings and foundations to permit placing and removal of concrete form work, installation of services, other construction and for inspection.
  2. In excavating for footings and foundations, take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is to be placed. Trim bottoms to required lines and grades to leave solid base to receive concrete.
- F. Excavation for Pavements: Cut surface under pavements to comply with cross-sections, elevations and grades as shown.
- G. Excavations for Trenches: Performed as part of work installed.
1. Dig trenches to the uniform width required for the particular item to be installed, sufficient minimum width as shown on the Drawings and to provide ample working room.
  2. Excavate trenches to the depth indicated or required. Carry the depth of trenches for piping to establish the indicated flow lines and invert elevations. Beyond the building perimeter, keep bottoms of trenches sufficiently below grade to avoid freeze-ups.
  3. When unstable pipe foundation is encountered, place a minimum of 12 inches of trench stabilization material under the pipe bedding material to stabilize the trench.
  4. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for the entire body of the pipe.
  5. Backfill trenches prior to tests and inspections. Use care in backfilling to avoid damage or displacement of pipe systems.
- H. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

- I. Dust: Assume full responsibility for all alleviation or prevention of dust nuisance on or about the site in compliance with regulatory requirements.

### 3.3 COMPACTION

- A. General: Control soil compaction during construction providing minimum percentage of density specified for each area.
- B. Prior to fill placement or aggregate base course placement, the subgrade shall be proof-rolled with a fully-loaded 10 to 12 yard dump truck. Any areas that pump, heave or appear soft shall be over excavated and backfilled a minimum of 12 inches with select granular fill material.
- C. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum dry density for soils which exhibit a well-defined moisture density relationship determined in accordance with ASTM D 1557.
  1. Structural Fill: Compact exposed subgrade where disturbed, and each layer of backfill or fill material to 92 percent for fine grained soils and 95 percent for granular material of maximum dry density (MDD). Backfill within a horizontal distance of 3 feet and from walls should be compacted to 90% MDD unless flatwork will be placed adjacent to the wall, which should be compacted to 95% MDD.
  2. Non-Structural Landscape Fill: Compact top 6 inches of subgrade, and each layer of fill material to 85 percent of MDD.
  3. Trench Backfill: Pipe base and pipe zone compacted to 90% of MDD. In pavement areas compact top 36 inches of subgrade shall be compacted to 95%, and each layer of backfill or fill material to 90 percent of MDD. Outside pavement areas compact fill to 90% MDD.
  4. Pavements: The subgrade within 12 inches of the bottom of the aggregate base course shall be compacted to 95% MDD.
- D. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material. Prevent free water appearing on surface during or subsequent to compaction operations.
  1. Remove and replace, or scarify and air dry, soil material too wet to permit compaction to specified density.
  2. Soil material removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to satisfactory value.

### 3.4 BACKFILL AND FILL

- A. In all excavations, unless otherwise specified, use satisfactory excavated or imported material for backfill which has been sampled and tested by a soil testing service employed by the Owner.

On-site materials may be used in structural fills only during dry conditions when optimum moisture content can be maintained.

- B. Use imported granular material in wet conditions as structural fill.
- C. Backfill excavations as promptly as work permits, but not until completion of the following:
  - 1. Acceptance by Engineer of construction below finish grade including, where applicable, waterproofing, dampproofing, drainage pipe and perimeter insulation.
  - 2. Inspection, testing, approval and recording of locations of underground utilities.
  - 3. Removal of shoring and bracing and backfilling of voids with satisfactory materials.
  - 4. Removal of trash and debris.
- D. Placement and Compaction: Place backfill and fill materials in layers not more than 8 inch with native material and not more than 12 inches in loose depth for granular material compacted by heavy compaction equipment, and not more than 8 inches in loose depth for material compacted by hand-operated tampers.
  - 1. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content.
  - 2. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification.
  - 3. Do not place backfill or fill material on surfaces muddy, frozen, or containing frost or ice.
  - 4. Place backfill and fill materials evenly adjacent to structures, to required elevations. Take care to prevent wedging action of backfill against structures by carrying the material uniformly around structure to approximately same elevation in each lift.

### 3.5 GRADING

- A. General: Uniformly grade areas of work including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.
- B. Grading Outside Building Lines: Grade areas adjacent to building lines to be no more than 8 inches from any building siding and to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes. Grading contractor to provide for placement of top soil, as required, to the finish grades indicated on the drawings.
- C. Grading Surface of Fill Under Building Slabs: Grading smooth and even, free from voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of ½-inch when tested with a 10-foot straightedge.

3.6 FIELD QUALITY CONTROL

- A. General: The Contractor is responsible for preparing for and scheduling all required testing activities.
- B. Quality Control Testing During Construction: Allow soil testing service retained by the Owner to observe, test and approve subgrades and fill layers before further construction work is performed.
- C. If in the opinion of the Engineer, based on soil testing service reports and observations of subgrades and fills which have been placed are below specified density, provide corrective work as required to reach specified density at no additional expense.

3.7 PROTECTION

- A. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, compact to required density and provide other corrective work as specified, prior to further construction.

END OF SECTION 312300

## SECTION 312513 - EROSION CONTROL

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Specification Section, apply to this Section.

#### 1.2 SECTION INCLUDES

- A. Furnishing, placing and maintaining all erosion control and protective materials.

#### 1.3 RELATED SECTIONS

- A. Section 312300 – Earthwork.

#### 1.4 REGULATORY REQUIREMENTS

- A. Conform to the requirements of the Washington County and Clean Water Services.
- B. Contractor shall adhere to the requirement of the DEQ 1200C permit requirements and shall supplement the erosion control plan requirements to meet the specific site demands to prevent sediment laden water from leaving the site.
- C. Inspecting, monitoring, and maintenance of erosion control measures, including documentation of these activities shall be the responsibility of the contractor in conformance with the 1200C permit requirements.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Gravel: All material furnished for “Gravel Construction Entrances” shall be clean pit run, or 2"-0 crushed rock.
- B. Sediment Fences: Woven construction fabric specifically designed to control sediment runoff. Acceptable material is Amoco 1380 Silt Stop, or equal.
- C. Posts/Stakes:
  - 1. 2"x2" standard or better wood posts (sediment fences).

2. 1"x2" standard of better wood stakes (Waddles)
  3. Steel fence posts (sediment fences).
  4. 2"x2" standard or better wood stakes (straw bales).
- D. Straw Bales: 40 to 60 pound rectangular bales of cereal grain or seed straw.
- E. Bio-Bags: Clean 100% recycled wood product waste. Size of bag to be 18x8x30-inches and weigh approximately 45 pounds and made of 1/2-inch plastic mesh.
- F. Hydro-Seeding: Seed, fertilizer and mulch acceptable to the landscape architect.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. The Contractor shall comply with all regulatory requirements.
- B. Prior to performing any site clearing or earthwork operations, install a sediment barrier as shown on the Drawings. The sediment barrier shall be in conformance to the details shown on the Drawings.

#### 3.2 SEDIMENT BARRIERS

- A. The Contractor shall place an adequate sediment barrier around the site perimeter as shown on the Drawings.
- B. Place sediment barriers at toes of slopes. Embed sediment fences 12 inches below ground. Embed straw bales 4 to 6 inches. Embed wattles one half the diameter.
- C. Provide posts at 6-foot maximum spacing for sediment fences and 4-foot o.c. for waddles.
- D. Provide 2 stakes per straw bale driven a minimum of 12 inches into the ground.
- E. Provide inlet protection around the on-site catch basins and area drains per drawing details.

#### 3.3 GRAVEL CONSTRUCTION ENTRANCE

- A. Provide a gravel construction entrance pad as shown on the Drawings.
- B. Gravel depth to be 8-inch minimum thickness with the top of the pad to be the same elevation as the bottom of the pavement structural section.

3.4 INLET PROTECTION

- A. Provide inlet protection for all existing and new inlets within the property boundary and within the influence of the work area to protect the existing and new storm sewers from sediment.

3.5 MAINTENANCE OF DEVICES

- A. The contractor shall monitor and document maintenance of the erosion control measures as required by the 1200C permit.
- B. Depth of sediment accumulated behind barrier shall be less than one foot. Periodically remove excess sediment and regrade onto slopes to maintain fence.
- C. Repair and/or reestablish barriers that are damaged or temporarily removed immediately after such instance occurs.
- D. Remove and replace contaminated gravel with clean gravel as necessary to mitigate mud and dirt transported to public streets. Prior to construction of the asphalt pavement parking area, remove and replace contaminated gravel.
- E. Provide slope protection, seeding, and all other erosion control measures as specified and shown on the Drawings.

END OF SECTION 312513

## SECTION 321216 - ASPHALTIC CONCRETE PAVING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SECTION INCLUDES

- A. Asphaltic concrete paving, wearing binder or base course.

#### 1.3 RELATED SECTIONS

- A. Section 312300 - Earthwork.

#### 1.4 REFERENCES

- A. TAI - (The Asphalt Institute) - MS-2 Mix Design Methods for Asphalt Concrete and Other Hot Mix Types.
- B. TAI - (The Asphalt Institute) - MS-3 Asphalt Plant Manual.
- C. TAI - (The Asphalt Institute) - MS-8 Asphalt Paving Manual.
- D. TAI - (The Asphalt Institute) - MS-19 Basic Asphalt Emulsion Manual.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. Paving: Standard duty pavement per Oregon Department of Transportation (ODOT) Specifications.

#### 1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with OSHD Specifications.
- B. Obtain materials from same source throughout.

#### 1.7 ENVIRONMENTAL REQUIREMENTS

- A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F, or surface is wet or frozen.

- B. Place bitumen mixture when temperature is not more than 15 F degrees below bitumen suppliers bill of lading and not more than maximum specified temperature.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. "OSHD Specifications" refers to the most recent edition of the State of Oregon Highway Division Standard Specifications for Construction.
- B. Aggregate Quality: OSHD Supplemental Specification Section 00744.10.
- C. Asphalt Cement: PG 64-22 per OSHD Specification 0744.11.
- D. Job Mix Formula: Contractor to supply a current year mix design for Level 2 and Level 3 pavement per OSHD 00744.13.
- E. Tack Coat: Use CSS-1 or CSS-1H per OSHD 00730.

### 2.2 SOURCE QUALITY CONTROL AND TESTS

- A. Submit proposed mix design of each class of mix for review prior to beginning of work. Mix design shall be less than one year old.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that compacted aggregate base is compacted and shaped and ready for placing asphaltic concrete pavement.
- B. Verify gradients and elevations of base are correct and that all compaction requirements have been satisfactorily been met.

### 3.2 PREPARATION - TACK COAT

- A. Apply tack coat on asphalt or concrete surfaces at uniform rate of 0.05-0.15 gal/sq yd.
- B. Apply tack coat to contact surfaces of curbs.
- C. Coat surfaces of manhole, catch basin, and clean-out frames with oil to prevent bond with asphalt pavement. Do not tack coat these surfaces.
- D. If asphalt is to be placed in two lifts, the surface shall be cleaned and tacked prior to placing the second lift.

3.3 PLACING ASPHALT PAVEMENT - SINGLE COURSE

- A. Install Work in accordance with OSHD Specification for Level 2 or 3 pavements, see plan.
- B. Place to thickness identified in schedule at end of Section.
- C. Install manhole, and clean-out frames in correct position and elevation.
- D. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- E. Compact pavement per section OSHD 00744.49.
- F. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.4 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

- A. Place base course to thickness shown on the drawings (minimum lift thickness 2 inches and maximum lift thickness of 3 inches for 1/2" ACP).
- B. Place tack coat between base and wearing course.
- C. Place wearing course to thickness shown on the drawings.
- D. Install manhole and clean-out frames in correct position and elevation.
- E. Compact pavement per section OSHD 00744.49.
- F. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.5 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.
- B. Scheduled Compacted Thickness: Within 1/4 inch.

3.6 FIELD QUALITY CONTROL

- A. The contractor shall have a field technician on site to establish the rolling pattern and determine the number of passes of each roller to provide the optimum compaction for the mixture. Once the rolling pattern has been established, the contractor shall maintain the pattern throughout.
- B. Record asphalt temperature during placement and adhere the breakdown and intermediate rolling temperature requirements.
- C. One nuclear density test shall be taken and recorded for every 2000 SY of paving or a minimum of four tests per days paving.

3.7 PROTECTION

- A. Immediately after placement, protect pavement from mechanical injury for until surface temperature is less than 140 degrees F. Permission from the Owner is required to allow construction traffic on finished asphaltic pavements.
- B. Finished striping will not be applied within 14 days of paving unless instructed by the engineer.

END OF SECTION 321216

## SECTION 321314 – CONCRETE CURBS AND WALKS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Portland cement concrete paving, curbs and sidewalks as shown on Drawings.
  - 2. Portland cement concrete for use in site structures.

#### 1.3 SUBMITTALS

- A. Provide samples, manufacturer's product data, test reports, and materials' certifications as required in referenced sections for concrete and joint fillers and sealers.
- B. Provide a 3-foot square sample plane each of light- and heavy-broom-finished, special scoring, texture, color and exposed aggregate finished flatwork, showing specified finishes and joints.
- C. Maintain approved sample on-site in a secure location for the duration of the Project. Remove from site when directed.

#### 1.4 QUALITY ASSURANCE

- A. Codes and Standards: Comply with local governing regulations if more stringent than herein specified.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Forms: Steel, wood or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects.
  - 1. Use flexible spring steel forms or laminated boards to form radius bends as required.

2. Coat forms with a nonstaining form release agent that will not discolor or deface surface of concrete.
- B. Reinforcing Materials:
1. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 60.
  2. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A 185. Furnish in flat sheets, not rolls, unless otherwise acceptable to Engineer.
  3. Fabricated Bar Mats: Welded or clip-assembled steel bar or rod mats, ASTM A 184. Use ASTM A 615, Grade 60 steel bars, unless otherwise indicated.
  4. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 60. Cut bars true to length with ends square and free of burrs.
  5. Supports for Reinforcement: Chairs, spacers, dowel bar supports and other devices for spacing, supporting, and fastening reinforcing bars, welded wire fabric, and dowels in place. Use wire bar-type supports complying with CRSI specifications.
- C. Concrete Materials: Comply with requirements of applicable Division 3 sections for concrete materials, admixtures, bonding materials, curing materials and others as required.
1. Portland Cement: ASTM C150, Type IA or IIA.
    - a. Use one brand of cement throughout Project unless otherwise acceptable to Architect/ Engineer.
  2. Fly Ash: ASTM C 618; Type F.
  3. Normal-Weight Aggregates: ASTM C 33, Class 4, and as follows. Provide aggregates from a single source.
    - a. Maximum Aggregate Size: 1½ inches.
    - b. Do not use fine or coarse aggregates that contain substances that cause spalling.
    - c. Local aggregates not complying with ASTM C 33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to Engineer.
  4. Water: Potable.
  5. Air Entrainment: ASTM C 260.
  6. Chemical Admixture: ASTM C 494.
- D. Expansion Joint Materials: ASTM D 994, preformed asphalt impregnated, ½-inch thick.
- E. Liquid-Membrane Forming and Sealing Curing Compound: Comply with ASTM C 309, Type I, Class A unless other type acceptable to Engineer. Moisture loss no more than 0.055 gr./sq.cm. when applied at 200 sq.ft./gal.
- F. Bonding Compound: Acrylic or styrene butadiene base, rewettable type.
- G. Epoxy Adhesive: ASTM C 881, 2-component material suitable for use on dry or damp surfaces. Provide material "Type", "Grade" and "Class" to suit project requirements.

H. Color Additives: Dark Gray by Davis Colors

1. Contact Information: Davis Colors, [www.daviscolors.com](http://www.daviscolors.com), 800-356-4848, [info@davidcolors.com](mailto:info@davidcolors.com)
2. Type:
  - a. Concentrated pigments specially processed for mixing into concrete and complying with ASTM C979.
  - b. Color additives containing carbon black are not acceptable.
3. Color Additive Delivery:
  - a. Automated Dispensing: Meter and dispense colors using computer-controlled automated color weighing and dispensing system. Use Davis Colors Chameleon liquid metering system and Hydrotint color additives.
  - b. Manual Dispensing: Use Davis Colors Mix-Ready powdered color additives in pre-measured disintegrating bags.

I. Sand Finish Additive: Black Sand concrete additive to darken concrete.

2.2 CONCRETE MIX, DESIGN AND TESTING

- A. Prepare design mixes for each type and strength of normal-weight concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use a qualified independent testing agency for preparing and reporting proposed mix designs.
1. Do not use the Owner's field quality-control testing agency as the independent testing agency.
  2. Limit use of fly ash to 25 percent of cement content by weight.
- B. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:
1. Compressive Strength (28-Day):
    - a. Sidewalks and Curbs: 3000 psi.
    - b. Site Structures: 3000 psi.
  2. Slump Limit at Point of Placement: 4 inches.
    - a. Slump limit for concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches.
  3. Air Content: 5 percent  $\pm$  1%.

- C. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, project conditions, weather, test results or other circumstances warrant.
- D. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94.
  - 1. When air temperature is between 85 degrees F (30 degrees C) and 90 degrees F (32 degrees C), reduce mixing and delivery time from 1½ hours to 75 minutes; when air temperature is above 90 degrees F (32 degrees C), reduce mixing and delivery time to 60 minutes.
- E. Color Additives: Mix in accordance with manufacturer's instructions. Mix until color additives are uniformly dispersed throughout mixture and disintegrating bags, if used, have disintegrated.
- F. Sand Finish: Chemical Surface Retarder
  - 1. ACC Top Face Surface Retarders. Rate of application by manufacturer, to be confirmed via mockup.

### PART 3 - EXECUTION

#### 3.1 SURFACE PREPARATION

- A. Remove loose material from compacted subbase immediately before placing concrete.
- B. Proof-roll prepared subbase surface to check for unstable areas and need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.

#### 3.2 FORM CONSTRUCTION

- A. Set forms to required grades and lines, braced and secured. Install forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.
- B. Check completed formwork for grade and alignment to following tolerances:
  - 1. Top of forms not more than 1/4-inch in 10 feet.
  - 2. Vertical face on longitudinal axis, not more than 1/2-inch in 10 feet.
- C. Clean forms after each use and coat with form release agent as required to ensure separation from concrete without damage.

#### 3.3 REINFORCEMENT

- A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for placing and supporting reinforcement.

- B. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

### 3.4 CONCRETE PLACEMENT

- A. Comply with requirements and with ACI 304R for measuring, mixing, transporting, and placing concrete.
- B. Do not place concrete until subbase and forms have been checked for line and grade. Moisten subbase if required to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- C. Place concrete by methods that prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocation of reinforcing, dowels and joint devices.
- D. Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- E. Deposit and spread concrete in a continuous operation between transverse joints as far as possible. If interrupted for more than ½ hour, place a construction joint.
- F. Screed paved surfaces with a straightedge and strike off. Use bull floats or darbies to form a smooth surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces prior to beginning finishing operations.
- G. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off and screed.
  - 1. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer or use bonding agent if acceptable to Architect/Engineer.
- H. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete.
- I. Slip-Form Pavers: When automatic machine placement is used for paving, submit revised mix design and laboratory test results that meet or exceed requirements. Produce paving to required thickness, lines, grades, finish and jointing as required for formed paving.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.
- J. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
- K. Cold-Weather Placement: Comply with provisions of ACI 306R 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 air temperature has fallen to or is expected to fall below 40 degrees F (4 degree C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F (10 degrees C) and not more than 80 degrees F (27 degrees C) at point of placement.
  2. Do not use frozen materials or materials containing ice or snow.
  3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix design.
- L. Hot-Weather Placement: Place concrete complying with ACI 305R and as specified when hot weather conditions exist.
  1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 degrees F (32 degrees C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
  3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

### 3.5 JOINTS

- A. General: Construct expansion, weakened-plane (contraction), and construction joints true to line with face perpendicular to surface of concrete. Construct transverse joints at right angles to the centerline, unless otherwise indicated.
- B. When joining existing structures, place transverse joints to align with previously placed joints, unless otherwise indicated.
- C. Weakened-Plane (Contraction) Joints: Provide weakened-plane (contraction) joints, sectioning concrete into areas as shown on Drawings. Construct weakened-plane for a depth equal to at least ¼ concrete thickness, as follows:
  1. Tooled Joints: Form weakened-plane joints in fresh concrete by grooving top portion with a recommended cutting tool and finishing edges with a jointer.
  2. Inserts: Use embedded strips of metal or sealed wood to form weakened-plane joints. Set strips into plastic concrete and carefully remove strips after concrete has hardened.

- D. Construction Joints: Place construction joints at end of placements and at locations where placement operations are stopped for more than ½ hour, except where such placements terminate at expansion joints.
  - 1. Construction joints as shown or, if not shown, use standard metal keyway-section forms.
  - 2. Where load transfer-slip dowel devices are used, install so that one end of each dowel bar is free to move.
- E. Expansion Joints: Provide premolded joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, walks and other fixed objects, unless otherwise indicated.
  - 1. Locate expansion joints at 45' o.c. or as shown on Drawings.
- F. Extend joint fillers full width and depth of joint, not less than ½-inch or more than 1-inch below finished surface where joint sealer is indicated. If no joint sealer, place top of joint filler flush with finished concrete surface.
- G. Finish joint fillers in one-piece lengths for full width being placed wherever possible. Where more than one length is required, lace or clip joint filler sections together.
- H. Protect top edge of joint filler during concrete placement with a metal cap or other temporary material. Remove protection after concrete has been placed on both sides of joint.
- I. Fillers and Sealants: Apply joint sealant to all joints in pedestrian or vehicular traffic areas.

### 3.6 CONCRETE FINISHING

- A. After striking-off and consolidating concrete, smooth surface by screeding and floating. Use hand methods only where mechanical floating is not possible. Adjust floating to compact surface and produce uniform texture.
- B. After floating, test surface for trueness with a 10-foot straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide a continuous smooth finish, true to within ¼-inch in 10 feet.
- C. Work edges of gutters, back top edge of curb, and formed joints with an edging tool, and round to ½-inch radius, unless otherwise indicated. Eliminate tool marks on concrete surface.
- D. After completion of floating and when excess moisture or surface sheen has disappeared, complete troweling and finish surface as follows:
  - 1. Scoring pattern and surface finish will be as directed by the Architect.
- E. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point-up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by Engineer.

### 3.7 CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with the recommendations of ACI 306R for cold weather protection and ACI 305R for hot weather protection during curing.
- B. Evaporation Control: In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before floating.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these.

### 3.8 REPAIRS AND PROTECTION

- A. Repair or replace broken or defective concrete, as directed by Engineer.
- B. Drill test cores where directed by Engineer when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement with Portland cement concrete bonded to pavement with epoxy adhesive.
- C. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just before final inspection.

### 3.9 FIELD QUALITY CONTROL

- A. Four concrete test cylinders will be taken for every 100 or less cu. yds. of each class of concrete placed each day or as directed by Engineer.
- B. One additional test cylinder will be taken during cold weather and cured on site under same conditions as concrete it represents.
- C. One slump test will be taken for each set of test cylinders taken.
- D. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

END OF SECTION 321314

## SECTION 323113 - CHAIN LINK FENCES AND GATES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Fence framework, fabric, and accessories.
- B. Excavation for post bases; concrete foundation for posts.
- C. Manual gates and related hardware.

#### 1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete anchorage for posts.

#### 1.3 REFERENCE STANDARDS

- A. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric; 2011a.
- B. ASTM F567 - Standard Practice for Installation of Chain-Link Fence; 2011.
- C. ASTM F668 - Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric; 2011.
- D. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures; 2013.

#### 1.4 SUBMITTALS

- A. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.
- B. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components.

#### 1.5 QUALITY ASSURANCE

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

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Provide all fabric, posts, rails, rods, bars, fittings, and hardware as required to make a complete installation.
- B. Posts, Rails, and Frames: ASTM F1083 Schedule 40 hot-dipped galvanized steel pipe, welded construction, minimum yield strength of 30 ksi.
  - 1. Posts and rails 4 inches and under to meet ASTM F 1043 Group 1-C.
  - 2. Posts and rails over 4 inches to meet ASTM F 1043 Group 1-A.
- C. Wire Fabric: ASTM A 392 zinc coated class 1 steel chain link fabric manufactured by Pacific Fence and Wire Company or approved equal.
- D. Vinyl Coated Fabric: Meet ASTM F 668 Class 2B, Fused-Bonded, as manufactured by Pacific Fence & Wire Company or approved equal.
- E. Fence Fittings: Meet ASTM F 626 (Domestic).
- F. Concrete: Type specified in Section 033000.

### 2.2 COMPONENTS FOR FENCES 6 FEET TALL

- A. Line Posts: 6 foot fence or less: 2.38 inch outside diameter.
- B. Corner and Terminal Posts: 3.5 inch outside diameter.
- C. Gate Posts: 3.5 inch square outside diameter.
- D. Top, Bottom, and Brace Rail: 1.66 inch outside diameter, plain end, sleeve coupled.
- E. Gate Frame: 1.66 inch square for welded fabrication.
  - 1. Single Swing Gate Frames (at garden): 1.66 inch diameter for welded fabrication
  - 2. Double swing Gate Frames: 1.5 inch square for welded fabrication.
- F. Fabric: 2 inch diamond mesh interwoven wire, 6 gage, 0.1620 inch thick, top selvage knuckle end closed, bottom selvage twisted tight.
- G. Tension Bars: 3/16 inch x 3/4 inch x fabric height less 2 inches.
- H. Heavy Brace and Tension Bands: 1/8 inch x 1 inch.
- I. Vinyl coated fence ties: 9-gauge finish with an 11-gauge core wire.
- K. Galvanized Hog Rings: 9-gauge Class III.

- L. Vinyl Coated Hog Rings: 9-gauge finish.
- M. Truss Rods: 5/16 inch outside diameter minimum.

## 2.3 ACCESSORIES

- A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.
- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; galvanized steel.

## 2.4 GATES

- A. Gates to comply with ASTM F 1043 Group 1-C, ASTM F 900, and have commercial grade hardware.
- B. Hardware for Single Swinging Gates: Two (2) hinges for gates up to 72 inches high, Three (3) hinges for taller gates; fork latch with gravity drop and padlock hasp; keeper to hold gate in fully open position.
  - 1. Provide 90-degree commercial bulldog hinge or approved equal.
  - 2. As noted on plans provide 180-degree commercial bulldog hinge or approved equal.

## 2.5 FINISHES FOR ALL FENCE MATERIALS

- A. Components and accessories: Powder coat all posts, rails, frames, components, and accessories.
- B. Fabric: Vinyl coated over coating of 2.0 oz/sq ft galvanizing.
- C. Color(s): Black.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install framework, fabric, accessories and gates in accordance with ASTM F567.
- B. Place fabric on outside of posts and rails, unless indicated otherwise.
- C. Set intermediate posts plumb. Slope top of concrete for water runoff.
- D. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.
- E. Provide top rail through line post tops and splice with 6 inch long rail sleeves.
- F. Install center brace rail on corner gate leaves.

- G. Fabric ends shall occur only at terminal, corner, or pull posts.
- H. Do not stretch fabric until concrete foundation has cured 28 days.
- I. Runs of fence more than 500 feet in length shall have at least one intermediate 3 inch outside diameter pull post with braces in two directions. Maximum distance between intermediate posts is 500 feet.
- J. Position bottom of fabric 1 inch above finish grade.
- K. Space hog rings at a maximum spacing of 24 inches.
- L. Install fence ties as outlined in ASTM standard.
- M. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips with maximum 12 inches on center.
- N. Install hardware and gate with fabric and barbed wire overhang to match fence.
- O. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.
- P. Fence ties and fabric edges shall be appropriately knuckled and tied back so that there are no protruding sharp edges.

### 3.2 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From True Position: 1 inch.

END OF SECTION 323113

## SECTION 328000 - IRRIGATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Installation of an electric solenoid controlled underground sprinkler system of PVC pipe and fittings with pop-up heads.
- B. Installation of Irrigation Control Assembly and control wires, at new shrub and lawn zones.

#### 1.2 RELATED REQUIREMENTS

- A. Section 015639 - Temporary Tree and Plant Protection
- C. Division 31 - Earthwork
- D. Section 329000 - Planting

#### 1.3 REFERENCE STANDARDS

- A. ASTM D1784: Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- B. ASTM D1785: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- C. ASTM D2464 - Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- D. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- E. ASTM D 2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2004 (Reapproved 2009).

#### 1.4 PROTECTION

- A. Protect existing improvements and growth in areas to remain undisturbed until completion of project. Leave area in similar condition as found.
- B. Protect utilities and maintain in continuous operation or in operational condition during work. Repair damage to known utilities at Contractor's expense.

- C. Use means necessary to protect materials of this Section before, during, and after installation and to protect installed Work and materials of other trades. In the event of damage immediately make repairs and replacements as directed by Owner's Representative.

#### 1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work with other trades affecting and affected by Work of this Section.
- B. Preinstallation Meeting: Convene one week (minimum) prior to commencing work of this Section to coordinate utility marking procedures.

#### 1.6 SUBMITTALS

- A. Product Data: Submit manufacturer's printed data covering products and installation instructions.
- B. Quality Assurance Data: Submit license information and project references including name and location of previous projects, date of installation, square footage of areas with irrigation work, description of irrigation system, and Owner's contact information.
- C. Record Documents: Record actual locations of installed irrigation components on a clean set of plans. Use white out and red ink to legibly re-draft as-built information.
  - 1. Produce and keep current throughout the project.
  - 2. Indicate two dimensions for valves, stub outs, and main line T's, L's, ends, elbow's, and change in direction.
  - 3. Include spare parts list and local source for replacement parts.
  - 4. Submit to Owner's Representative for approval.
  - 5. Final submittal shall include fully laminated, clean print of final irrigation Record Drawing, reduced by 50%, with zones clearly color-coded for posting near automatic controller.
- D. Operation and Maintenance Data:
  - 1. Provide written instructions at System Demonstration for operation and maintenance of system and controls, seasonal activation and shutdown, and manufacturer's parts catalog.
  - 2. Submit chart showing actual precipitation rates for each zone.
  - 3. Prepare a program for the irrigation controller for Spring/Summer; Summer; Summer/Fall using historical weather data and averages. Include start times, watering duration, day of week, repeat cycle mode, program mode, precipitation rates in inches per hour, and application quantities. Coordinate operation and programming with Owner's Representative.
- E. Maintenance Materials: Provide the following for Owner's use in maintenance of project.
  - 1. Extra Valve Keys for Manual Valves: Two.
  - 2. Extra Valve Box Keys: Two.

3. Wrenches: One for each type head core and for removing and installing each type head.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing Work of this Section who has successfully completed a minimum of 5 comparable scale projects and have the following licenses:

1. For Irrigation Work:
  - a. Valid Oregon Landscape Contractors license.
  - b. Valid Oregon Landscape Business license.
2. For Plumbing Work:
  - a. Valid Oregon Plumbing license.
  - b. Valid Oregon Landscape Contractor license.
3. Successfully completed at least 5 comparable scale projects.
  - a. Submit names, addresses, dates, Owners and locations of previous projects if requested by Owner's Representative.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in original unopened packaging with legible manufacturer's identification.
- B. Comply with manufacturer's recommendations for storage and protection.
  1. Store in a cool, dry place out of direct sunlight.
  2. Protect from damage by the elements and construction procedures.
  3. Store plastic pipe on firm, level supports.
  4. Store plastic pipe cement in cool location.

#### 1.9 ENVIRONMENTAL CONDITIONS

- A. Temperature of mating surfaces of plastic pipe and fittings to be between 40 degrees Fahrenheit and 100 degrees Fahrenheit. Perform no PVC Solvent welding in rainy weather except under cover.

#### 1.10 REVIEWS

- A. Request the following reviews by the Owner's Representative two days (min.) in advance:
  1. Irrigation Head Layout Review
  2. Pressure Test and Mainline Installation

- 3. System Review
- 4. System Demonstration to Owner

- B. Coordinate Reviews to coincide with regular progress meetings where possible.
- C. Work shall not be covered or enclosed until it has been inspected, pressure tested, and approved by the Owner's Representative.

#### 1.11 MAINTENANCE

- A. During period between system installation and Final Completion provide maintenance to assure proper operation of the irrigation system.
- B. Provide 90 day maintenance period following Final Completion. Operate, review, and maintain irrigation system.

#### 1.12 WARRANTY

- A. Warranty period shall be one year following Final Completion or one full operating season following Final Completion, whichever is longer.
- B. Contractor guarantees materials furnished under this Contract will be as specified and the Work will be free of defects in compliance with the Contract Documents.
- C. Irrigation system must be in proper working condition at the end of the warranty period. At no additional cost to the Owner replace Work of this Section as necessary to restore system to proper working condition following the Contract Documents.
- D. Visit and inspect Work at least once a month during warranty period and notify Owner's Representative in writing of any observed conditions requiring attention. Failure to provide such notification renders deficiencies the Contractor's responsibility to rectify.
- E. Contractor is not responsible for loss or damage to Work of this Section caused by unusually extreme weather, vandalism, or lack of Owner's maintenance during warranty period.

### PART 2 - PRODUCTS

#### 2.1 IRRIGATION SYSTEM MATERIALS

- A. Use only new materials of brands and types shown on Drawings or specified herein.
- B. Similar materials must be products of one manufacturer unless otherwise approved.
- C. Substitutions: See Section 016000

## 2.2 PIPE MATERIALS

- A. Mainline Pipe and Lateral Line Pipe: Schedule 40 PVC Pipe, Type 1, normal impact: IPS, NSF approved conforming to ASTM D1784, ASTM D1785.
- B. Irrigation Sleeve: Schedule 40 PVC Pipe, Type 1, normal impact: IPS, NSF approved conforming to ASTM D1784, ASTM D1785.
- C. Threaded Fittings including PVC nipples and unions: Schedule 80 PVC with molded threads.
- D. Other Fittings: Type and style of connection to match pipe.
- E. Risers: One piece schedule 80 gray PVC Pipe, Type 1, threaded at both ends conforming to ASTM D1784 and ASTM D2464. No snap-risers.
- F. Flex Riser Assembly: 18 inch minimum, 3 feet maximum Swing-Pipe with transfer barb 90 degree ells at both ends and a marlex ell below the irrigation head.
- G. Electrical Conduit and Fittings:
  - 1. Underground: Plastic, Class 3, Federal Specification W-C-1094.
  - 2. Above Ground: Aluminum, Federal Specification WW-G-540.
- H. PVC Solvent Cement: NSF approved solvent for both Schedule 80 and Schedule 40 pipe and fittings with NSF approval for Type I and Type II PVC.
  - 1. Up to 2" pipe size: Medium Body PVC cement for pipe and fittings.
    - a. Weld-On 725, or approved equal.
  - 2. Larger than 2" pipe size: Heavy Body PVC cement for pipe and fittings.
    - a. Weld-On 711 Gray Glue, or approved equal.
- I. PVC Cleaner and Primer:
  - 1. IPS Weld-on P-75, or approved equal.

## 2.3 VALVES

- A. No new valves proposed, use existing.

## 2.4 VALVE BOXES

- A. Valve box of suitable size with tee top type lid bolted closed.
  - 1. Black box and green lid at lawn areas.
  - 2. Black box and black lid at plant bed areas.

B. Install valves in the following valve boxes:

1. Control Valve Assembly: (2) Carson 1419-12, T-Lid, or approved equal.
2. Quick Coupling Valves: Carson 910-12, T-Lid, or approved equal.
3. Manual Drain Valves: Carson 910-12, or approved equal.
4. Other Valves: Sized as appropriate for installation and maintenance.

2.5 IRRIGATION HEADS

- A. Makes and models shown on Drawings, or approved equal.

2.6 WIRE

- A. Zone Control Wire (2-Wire): 2 wire, 14 AWG Double Jacket Insulated, Dual Conductor – solid core.

1. Approved products:

- a. Maxi Wire by Rainbird, or approved equal.
- b. Paige Electric, Model # P7350D, or approved equal.

- B. Wire from Controller to Master Valve: Install according to manufacturer's wire schedule for valve specifications. 12 gauge minimum, type AWG, bearing U.S. approval, yellow wire color.

- C. Communication Wire: Install according to manufacturer's central control requirements. Wire from controller to flow sensor must be a single, unspliced length.

1. 19 gauge, PE 39 cable, 6 pair.

- D. Wire Connections: Direct bury splice Kit.

1. DBR/Y-6 by 3M, or approved equal.
2. Rainbird Waterproof Wire Connectors, or approved equal.

- E. Utility Locate Wire: 14 gauge minimum, type AVG-UF, bearing U.S. approval, blue in color.

2.7 TWO WIRE DECODERS

- A. No new decoders proposed, use existing.

2.8 IRRIGATION CONTROLLER

- A. Use existing Controller: Rainbird ESP-LXD two wire decoder controller with IQ Network Communication Cartridge.

## 2.9 BACKFILL MATERIALS

- A. Pea Gravel: 3/4 x 1/2 inch washed round rock.
- B. Sand: Clean, fill sand free of clay, rocks, organic matter, or other deleterious material.
- C. Topsoil or Loam: See Section 329000 - Planting.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that required utilities and sleeves are available, in proper location, and ready for use. Verify location, type, size, psi, and GPM of existing water lines, meters, and sleeves.
- B. Verify that surfaces and structures to receive Work are accurately sized and located, sound, secure, true, complete, and otherwise properly prepared.
- C. Verify electrical service, communication wire, and conduit for Irrigation Controller is properly sized and located.

### 3.2 PREPARATION

- A. System layout is diagrammatic. Route piping to avoid plants, ground cover, and structures. If field measurements differ slightly from Drawings modify work for accurate fit. If measurements differ substantially notify Owner's Representative prior to installation.
- B. Review layout requirements with other affected work. Coordinate locations of sleeves under paving to accommodate system and piping to minimize conflict with other work.
- C. Coordinate connections to existing irrigation system, including system shut down, new connections, system re-start, and scheduling of new irrigation zone run times with Owner's Representative.
- D. Irrigation Head Layout Review: Install flags at locations of irrigation heads and components shown on Drawings. Obtain Owner's Representative's approval and make adjustments to locations as directed. Coordinate marking of pipe trenches and location of valves prior to executing Work.

### 3.3 CUTTING OF PAVEMENT AND REPAIR

- A. Do no cutting of pavement for installation of Work without BSD Representative's approval.

### 3.4 TRENCHING

- A. Excavate trenches with uniform bottom and remove rocks and sharp objects to provide firm, even, clean base for pipe. Width of trench to be 1.5 times the outside diameter of the pipe.
- B. Trench Depth:
  - 1. Minimum Cover Over Installed Mainline Piping: 18 inches.
  - 2. Minimum Cover Over Installed Lateral Line Piping: 12 inches.
  - 3. Minimum Cover Over Installed Sleeves in Roadway: 24 inches.
  - 4. Minimum Cover Over Installed Sleeves at other paving: 6 inches from bottom of paving.
- C. More than one pipe is permitted in the same trench provided that:
  - 1. Two pipes may be stacked vertically if 4 inches of Sand separates them.
  - 2. Three or more pipes must be laid 2 inches apart horizontally.
- D. Where excavation is performed to excess levels backfill with Sand to proper levels.
- E. Keep trenches dry and frost free. Provide and operate pumping equipment to keep excavations free from standing water.
- F. Protect existing vegetation to remain. Cut no roots over two inches in diameter without approval of BSD Representative. Make cuts clean, straight, at right angles to roots. Paint cuts over 1-1/2 inches diameter with approved tree paint. Repair or replace damaged plant material.

### 3.5 SLEEVE INSTALLATION

- A. Sleeves may be jacked or pulled but cover requirements must be maintained. Jacking of PVC pipe is not permitted in rocky or bar run fills where there is potential for damage to pipes.
- B. Extend sleeves 12 inches beyond pavement edge or curb.
- C. Install level and perpendicular to sidewalks and pavement unless shown otherwise on drawings.
- D. Provide markers where sleeve ends are concealed.

### 3.6 PIPE BEDDING

- A. Mainline: Provide uniform bearing surface of Sand, 4 inches minimum depth, free of rocks and sharp objects under entire length of pipe.
- B. Lateral Line: Provide uniform bearing surface of clean topsoil, loam, or Sand. If rock or other deleterious materials are encountered bed pipe with 4 inches of Sand on all sides.

### 3.7 PIPE INSTALLATION

- A. Irrigation lines may be jacked or pulled but cover requirements must be maintained. Jacking of PVC pipe is not permitted in rocky or bar run fill or where there is potential damage to pipes.
- B. Install pipe in accordance with manufacturer's instructions and with the following minimum clearances around pipe:
  - 1. 2 inch diameter and smaller: 2 inches
  - 2. 2-1/2 inch diameter and larger: 4 inches
  - 3. Between irrigation and other utilities: 1 foot
- C. Threaded Plastic Pipe Installation:
  - 1. Do not use solvent cement on joints.
  - 2. Wrap threaded joints with teflon tape. Minimum 4 wraps of tape.
- D. Cemented Plastic Pipe Installation:
  - 1. Cut ends square using approved pipe cutter and bevel cuts with deburring tool.
  - 2. Clean pipe of scale, sand, dirt, etc. prior to assembling.
  - 3. Avoid using an excess amount of primer and cement when making joints; particularly on the inside of female pipe ends and fittings.
  - 4. Wipe off excess cement continuously as it appears on the surface of the pipe after making joints.
  - 5. Allow fifteen minutes of cure time on joints before moving or handling. Assemble pipe before lowering into trench.
  - 6. Snake lines to allow for contraction.
  - 7. Transition pipe sizes at fittings and not bell end of pipes.
  - 8. Install thrust blocks at 90 degree corners and tees.

### 3.8 THRUST BLOCK INSTALLATION

- A. Install 2500psi thrust block at mainline pipe corners, tees, ells, and stub outs.
  - 1. Pipe 2 - 3 inches in diameter: 1 cubic foot.

### 3.9 VALVE INSTALLATION

- A. Install plumb and square, as detailed, and according to manufacturer's specifications.
- B. Manual Drain Valves:
  - 1. Install at mainline low points and at outlet of control valves where laterals run uphill.
  - 2. Record locations on as-built drawings.
  - 3. Provide suitable length of 2" class 200 PVC pipe to fit over drain valve stem and install locking valve cap flush with finish grade. Provide two valve-operating keys of type and length required to operate valve.

- C. Quick Coupling Valve: install on 1" prefabricated swing joint assemblies.
- D. Install 1 valve in each valve box assembly.
- E. Valve Sump: Install a minimum of 2 cubic feet of Pea Gravel below each valve. Allow for 4 inches clearance between bottom of valve and valve sump.

### 3.10 VALVE BOX INSTALLATION

- A. Install plumb and square with adjacent construction with one valve in each valve box assembly.
- B. At Control Valve Assemblies bolt two valve boxes together as detailed.
- C. Permanently label valve type and zone number on inside of valve box lid.
- D. Set top of valve boxes flush with lawn or mulch at plant beds unless otherwise noted.
- E. Provide 12 square inches (min.) of support on each side of valve box as detailed.

### 3.11 CONTROL WIRE INSTALLATION

- A. Install wires below irrigation mainline with multiple wires bundled together at 5 foot maximum intervals in a continuous run. Notify Owner's Representative for approval prior if splices are required and locate in valve box.
- B. Use coded and labeled wires for each valve. Provide a numbered tag at each end of a wire at valve, and at controller. The number at each end of wire to be the same.
- C. Provide 48 inches loop in wires at each valve where controls are connected and at 100 foot maximum intervals between. Coil wire around 1/2 inch rebar dowel inside of valve box.
- D. Make electrical joints waterproof using specified connectors. Enclose joints in valve boxes.
- E. Install wire in continuous runs with no splices unless approved.
- F. Show wire routes and approved splice locations on As-Built drawings.

### 3.12 TRACER WIRE INSTALLATION

- A. Install trace or locate wire under main lines. Trace or locate wire is required in all mainline trenches and in all trenches with control wiring. Locate wire shall be a continuous run; any sections shall be spliced together with watertight splice connectors and locations shown on As-Built Drawings.

3.13 MAINLINE PRESSURE TEST AND INSPECTION

- A. Prior to backfilling and installing valves test irrigation mainline for leakage. Establish and maintain 100 psi pressure for 24 hours. Perform test a minimum of 24 hours after set-up of solvent weld. Notify Owner's Representative a minimum of 24 hours for review of pressure gauge at beginning and end of test period. Mainline will be accepted if pressure loss is less than 2 psi.
- B. Before testing, fill pipe with water and expel air from pipes.
- C. Following the pressure test but prior to backfilling, notify Owner's Representative for review of pipe, fittings, joints, thrust blocks, bedding, control wire installation, valves, and other materials for installation and water tightness.
- D. After successful pressure test and mainline inspection begin backfilling and assembly of zones and system components.
- E. Include test documentation in the O & M manual.

3.14 BACKFILLING

- A. Remove debris, sharp rocks, and decayable matter from areas to be back filled before proceeding.
- B. Main Lines: Provide 4 inch Sand cover over piping then place Utility Locate Wire the entire length of pipes where control wires are not present. Backfill remainder of trench with Topsoil or Loam.
- C. Lateral Lines: Backfill trench with Topsoil or Loam. Protect piping from displacement.
- D. At Paved Areas: Backfill trench with Sand under paved areas.
- E. Compact backfill in 6 inch lifts to match density of surrounding material. Install backfill to match adjacent elevations.

3.15 FLUSHING

- A. Mainline: Open valves and thoroughly flush piping system under full water head after piping, risers, and valves are installed. Maintain flushing for three minutes. Close valves and cap risers immediately after flushing.
- B. Second Flushing: Flush a second time after installation of lateral lines and sprinklers prior to nozzle installation. Flush under full water head for three minutes. Install nozzles after flushing.

3.16 SPRINKLER HEAD INSTALLATION

- A. Install plumb with top of Topsoil/Loam or Mulch as detailed and at locations shown on drawings. Allow a maximum of 3 inches clearance between sprinkler head and adjacent lawn or planting edge.
- B. Install 1 cubic foot Pea Gravel sump on all low irrigation heads where drainage occurs at zone shutdown.

3.17 SYSTEM REVIEW

- A. Prepare and start system in accordance with manufacturer's instructions. Prior to notifying Owner's Representative for review of the system review zones and make adjustments to ensure full and even coverage.
- B. Notify Owner's Representative for review of system operation to determine if water afforded to all areas is complete, adequate, and uniform.
- C. Adjust system for full water coverage as directed.

3.18 SYSTEM DEMONSTRATION TO OWNER

- A. Instruct Owner's personnel in operation and maintenance of system, including adjusting of sprinkler heads. Use operation and maintenance data as basis for demonstration.

3.19 CLEANING

- A. Remove excess excavation, backfill materials, and other left over materials from the site. Clean improvements soiled by Work of this Section.

END OF SECTION 328000

## SECTION 329000 - PLANTING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Soil Material placement.
- B. New trees, plants, ground cover, and lawns.
- C. Mulch and Fertilizer.
- D. Maintenance.

#### 1.2 RELATED REQUIREMENTS

- A. Section 015639 - Temporary Tree and Plant Protection.
- B. Section 328000 - Irrigation.
- C. Section 329223 – Sodding.

#### 1.3 DEFINITIONS

- A. Weeds: Any plant life not specified or scheduled. Includes seeds and roots.
- B. Plants: Living trees, plants, and ground cover specified in this Section, and described in ANSI Z60.1.

#### 1.4 REFERENCE STANDARDS

- A. Quality definitions, grading tolerances, root system condition, caliper height, branching, budding: ANSI/ANLA Z60.1 - American Standard for Nursery Stock, latest edition.
- B. Nomenclature conforms to "Standardized Plant Names," 1942 Edition, published by J. Horace McFarland Co., or "New Sunset Western Garden Book," listed in these references are those used most commonly in the nursery trade.

#### 1.5 PROTECTION

- A. Protect existing improvements and growth in areas to remain undisturbed until completion of project. Leave in similar condition as found.

- B. Maintain benchmarks, monuments, and other reference points. Replace if disturbed or destroyed.
- C. Contact local utility companies for verification of the location of underground utilities within the project area prior to starting excavation. Protect utilities and maintain in continuous operation or in operational condition during work. Repair damage to known utilities or related facilities in an approved manner at Contractor's expense.
- D. Protect drainage inlets and underground drain lines from infiltration or clogging by soils and mulch during construction until Final Completion.
- E. Protect materials of this Section before, during, and after installation. Protect installed work and materials of other trades. In the event of damage immediately make repairs or replacements as directed by BSD Representative.

#### 1.6 SUBMITTALS

- A. Maintenance Data: Include written instructions covering yearly recommended maintenance and care of plantings including fertilization, pest and disease control, weed control, mulching, and pruning.
- B. Quality Assurance Data: Submit license information and project references including name and location of previous projects, date of installation, square footage of areas with planting work, and Owner's contact information.
- C. Submit list of plant life sources within 14 calendar days of Agreement Date.
  - 1. Submit confirmation from supplier(s) that specified plant materials, meeting the specifications, have been secured.
  - 2. Include plant name, quantity, size, condition, and name of supplier.
  - 3. Submit certification letter from the sod supplier(s) stating the sod has been secured or contracted for delivery. Include the quantity, grass mix, and description.
- D. Product Data: Submit manufacturer's printed data for products and a list of suppliers.
- E. Sample: Submit a 2 quart sample of imported Soil Material and Mulch with supplier's name and specific location of source. Approval by Owner's Representative is required prior to delivery to the site.
- F. Submit analysis of Soil Material indicating USDA classification, macro and micro nutrients, organic matter, and recommendations for amendments.
- G. Invoices: Within 2 days of delivery submit invoices, load tickets, and truck measures for Organic Material and Mulch.

#### 1.7 QUALITY ASSURANCE

- A. Valid Oregon Landscape Contractor's license.

- B. Valid Oregon Landscape Business license.
- C. Herbicide applicators must have valid State of Oregon Herbicide Applicator's license.
- D. Installer Qualifications: Company specializing in installing and planting the plants with 10 projects of comparable scale successfully completed.
  - 1. Submit names, addresses, and dates of previous projects, Owners.

#### 1.8 COORDINATION

- A. Coordinate with other trades affecting and affected by Work of this Section.
- B. Pre-Installation Conference: Attend conference to coordinate Work of this Section and other related Sections.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
- B. Deliver plant life materials immediately prior to placement. Keep plants moist. Protect and maintain plant life until planted.
- C. Deliver products in original unopened packaging with legible manufacturer's identification.
- D. Seed containers shall show manufacturer's guaranteed analysis of seed mixture, percentage of purity, year of production, date and location of packaging, name and trademark, and conformance with governing regulations.
- E. Plants may be rejected if:
  - 1. Ball of earth surrounding roots has been dried out, cracked, or broken.
  - 2. Burlap, staves, wire baskets, or ropes required in connection with transplanting have been displaced.
  - 3. Grower or nursery identification labels have been displaced prior to acceptance.

#### 1.10 ENVIRONMENTAL CONDITIONS

- A. Do not install plant life and seed when ambient temperatures is below 32 degrees F or above 90 degrees F, wind speed exceeds 30 mph, or soil becomes saturated.
- B. Install plant materials and seed during periods which are normal for such work as determined by biological season, specified environmental conditions, accepted practice, and after all major construction work has been completed.
- C. Planting Seasons:

1. Seeding: Permitted between April 15 and September 1 unless otherwise approved. Refer to any jurisdictional requirements for seeding and establishment requirements.
2. Other: Permitted during any period, except when prohibited by other portions of this Section.

#### 1.11 REVIEWS

- A. See Part 3 Execution for review requirements.
- B. Request the following reviews by the Owner's Representative 2 days in advance:
  1. Subgrade preparation
  2. Soil Material placement
  3. Organic Material placement
  4. Finish grading
  5. Plant materials
  6. Planting mock-up
  7. Completion
- C. Coordinate all reviews to coincide with regular progress meetings where possible.

#### 1.12 RECORD DOCUMENTS

- A. Produce, keep current, and submit legible record documents on a clean set of plans and details supplied by the Owner's Representative. Use white-out and red ink to legibly re-draft actual locations of installed work.

#### 1.13 WARRANTY

- A. Provide one year warranty following Final Completion or one full growing season following Final Completion, whichever is later.
- B. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.
- C. Inspection: Visit work at least once a month during warranty period. Notify Owner's Representative and Owner in writing of any observed conditions requiring attention. Failure to provide such notification renders any deficiencies the Contractor's responsibility to rectify.
- D. At the end of the warranty period, as directed by Owner's Representative and at no additional cost to the Owner:
  1. Replace work not surviving, in poor condition, or not exhibiting satisfactory growth.
  2. Lawns must be healthy, dense, uniform, well sodded, and reasonably weed free as judged by the Owner's Representative
  3. Reset plant materials and stones which have settled or become un-set
  4. Replace plant materials which appear to be a different species or variety than specified.

5. Provide noxious weed eradication from imported Soil Material, if required and as specified herein.
  6. Complete warranty work within 30 days of warranty review.
- E. Contractor is not responsible for plant loss or damage to work during warranty period which is caused by unusually extreme weather, vandalism, or Owner's lack of maintenance.

## PART 2 - PRODUCTS

### 2.1 PLANTS

- A. Plants: Species and size identified in plant schedule, grown in climatic conditions similar to those in locality of the work.
- B. General:
1. Sizes, grades, and conditions are listed on Plant List. Quantities are shown for Contractor's convenience. Contractor is responsible for providing plants drawn on drawings.
  2. Cold storage stock unacceptable.
  3. Free of disease, decay, injury, insects, or indication of strawberry root weevil.
  4. Full foliated when in leaf.
  5. Furnish balled and burlapped (B&B) stock with solid, properly wrapped and secured, natural ball. Stock 2 inch caliper and up to be transported and handled with root ball in wire basket.
  6. Furnish container stock with sufficient roots to insure healthy growth but not root bound. When plant is removed from container soil must hold together and roots must be visible but not encircling.
  7. Free from Weeds or strawberry root weevil.
  8. Field grown trees and shrubs must have been transplanted or root pruned at least once no more than two years prior to this Contract.
  9. Container stock may be substituted for Balled and Burlapped (B&B) or Bare Root (BR) stock at any time.
- C. Trees shall have:
1. Single, straight, uniformly tapering trunks which are perpendicular to the ground, unless specified as multi-stemmed or otherwise on Plant List. Trees with co-dominant, damaged, crooked, or topped leaders will be rejected.
  2. Healthy and vigorous overall condition.
  3. Full and even branch distribution; structural scaffold branches at least 4 inches apart where they attach to the main trunk.
  4. Well-developed root systems. Trees with more than 2 inches of root ball soil covering root flare will be rejected.
  5. Grafts near ground level.
  6. Minimum/maximum branching heights above the ground unless specified otherwise on Plant List:

- a. 2.5 inch caliper tree: 6' - 7'
  - b. 2 inch caliper tree: 5' - 7'
  - c. 1.5 inch caliper tree: 4' - 6'
7. Trees shall be free of:
- a. Major structural defects including, but not limited to, branches with narrow angle of attachment (less than 40 degrees to the trunk), bark with major branch unions, and trees with co-dominant leaders.
  - b. Poor pruning practices including, but not limited to, stubbed branches and topped leader.
  - c. Damage to the trunk, branches, and root system including, but not limited to, bark abrasions, sun scald, and disfiguring knots.
8. Trees shall be freshly dug during the most recent favorable harvest season.

## 2.2 SOIL MATERIALS

### A. Planting Soil:

- 1. Loam: Imported, natural, fertile, friable; free of rock, clay, subsoil, clods, plants, roots, sticks, weeds, seeds, and other deleterious material. Shall conform to USDA soil texture class "loam".

### B. Premixed Planting Soil: For use at demonstration stormwater plant bed.

- 1. Premixed Planting Soil: Blended, organic soil mix composed of coarse sand, compost, and loam free of rock, clay, subsoil, clods, lumps, plants, roots, sticks, weeds, seeds, and other deleterious material, as approved.
  - a. Approved Products:
    - 1) BES Blend by City Bark and Recycling, Vancouver, WA (360) 253-8461, or approved.

### C. Structural Soil: refer to drawings and details.

### D. Source Quality Control: Submit analysis of Soil material indicating source of material, USDA classification, macro and micro nutrients, organic matter, and recommendations for amendments.

## 2.3 SOIL AMENDMENT MATERIALS

- A. Plant Bed Maintenance Fertilizer: Uniform composition, dry, and free flowing of proportion necessary to eliminate any deficiencies of topsoil, as recommended by the Soil Testing Agency.
- B. Planting Tablets: Sierra Chemical "Agriform" with 20-10-5 chemical analysis, or approved equal.

- C. Mycorrhizal Fungi: MycroApply® All Purpose Granular by Mycorrhizal Applications Inc., Grants Pass, Oregon (541-476-3985), or approved equal.
- D. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth of plants.
- E. Organic Material: 100% organic garden compost materials following guidelines and tested to meet the US Composting Council's seal of testing assurance.
- F. Biological Amendments:
  - 1. Soil ProVide by Earthfort, Corvallis, Oregon, or approved.
  - 2. Soil ReVive by Earthfort, Corvallis, Oregon, or approved.

## 2.4 MULCH MATERIALS

- A. Bark Mulch at Plant Beds: Hemlock species wood shavings, free of growth or weeds, "sliver free".
- B. Stone Mulch at Storm Water Plant Beds: 3/8 inch, washed, round river rock free of fines.

## 2.5 ACCESSORIES

- A. Wrapping Materials: Burlap.
- B. Stakes: 2 x 2 inch x 8 feet wood stakes, capable of at least 2 years ground burial, stained charcoal or black.
- C. Tree Ties: Chain lock tree ties, 1 inch wide, or approved.
- D. Root Deflectors: Extruded polyethylene panels, 18 inches deep, each having at least 4 molded root deflecting ribs at a maximum of 6 inches on center running from top to bottom of each panel; Panels are connected by means of integral male/female sliding locks.
  - 1. RS-18 by Root Solutions, San Rafael, CA; (800) 554-0914, or approved equal.

## 2.6 HERBICIDE

- A. Broad Spectrum Non-Selective: Buccaneer Plus, or approved equal.
- B. Selective for Broadleaves: Speed Zone, Weed-B-Gone, or approved equal.
- C. Selective for Grasses: Envoy or approved equal.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Prior to installation of Work of this Section, carefully inspect the work of others and verify that such work is complete to the point where this installation may properly commence.
- B. Verify that materials and surfaces to receive work specified herein are accurately sized, shaped, and located; sound, secure, true, complete, and otherwise properly prepared.
- C. Verify subgrades produce positive drainage and allow for placement of Soil Material, Amendments, and Mulch to specified depths.
- D. Do not install Work of this Section until all unsatisfactory conditions have been corrected. Beginning Work of this Section signifies acceptance of existing conditions.

#### 3.2 TOLERANCES

- A. Perform earthwork true to lines and grades, and to prevent ponding of water, with maximum variation in elevations of +/- 1/2 inch at subgrades and +/- 1/4 inch at finish grades.
- B. Compacted thickness of materials within 1/4 inch of specified thickness.

#### 3.3 SOIL TESTING

- A. Submit samples of Soil Material to testing agency.
- B. Provide planting plan to testing agency along with soil samples.
- C. Soil Testing to include the following:
  - 1. Chemical Soil Analysis (Macro and micro nutrients)
  - 2. USDA Soil Classification.
  - 3. Organic matter content.
- D. Provide test results and recommendations for amendments to Owner's Representative.
- E. Note to Bidders: The cost for products related to biological and fertilizer amendments will be a change to the contract. The labor for incorporating amendments shall be included in the bid based on descriptions in Part 3.

#### 3.4 PREPARATION OF SUBGRADE

- A. Prepare subsoil to eliminate uneven areas or low spots. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

- B. Remove foreign materials, weeds and undesirable plants and their roots, stones, rock, and dirt clods. Remove contaminated subsoil.
- C. Scarify subsoil to a depth of 6 inches where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.
- D. Verify subgrades, whether comprised of subgrade soil or fill drain freely. Test area by flooding with Owner's Representative present. Where water does not drain freely auger a 10 inch hole, minimum 1 per 1,000 square feet, through fill material and into subsoil, or minimum 4 feet deep into subsoil to establish positive drainage.
- E. Verify subgrades allow for placement of Soil Material, Amendments, and Mulch to depths specified.
- F. Notify Owner's Representative for Subgrade Preparation Review prior to placing Soil Material.

### 3.5 PLACING SOIL MATERIAL

- A. Soil Placement Schedule:
  - 1. At Plant Beds: 18 inches minimum depth.
  - 2. At Raised Garden Beds: Fill soil to top of bed.
  - 2. At Lawns: 6 inches minimum depth.
  - 3. At Structural Soil: 36 inches minimum depth.
  - 4. Place additional Soil Material as required to establish finish grades shown on drawings and to fill in depressions, blend grades, and produce positive drainage.
- B. Place Soil Material during dry weather and on dry unfrozen subgrade. Suspend Soil Material placement if subgrade or Soil Material become saturated.
- C. Phase Soil Material placement so that equipment does not travel over Soil Material already installed.
- D. Place Soil Material in a relatively dry state to depths specified at locations shown on Drawings:
  - 1. Remove stones, roots, grass, weeds, debris, and foreign material while spreading.
  - 2. Manually spread around existing trees, paving, and other structures to prevent damage.
  - 3. Establish levels, profiles, slopes, contours, and uniform gradients between given grade points as shown on Drawings.
  - 4. Eliminate uneven or low spots at lawns and plant beds.
  - 5. Fine grade Soil Material within specified tolerances.
- E. Notify Owner's Representative for Soil Material Placement Review prior to proceeding with Work.

3.6 ROOT DEFLECTOR INSTALLATION

- A. Install 10 foot lengths of Root Deflector at all curbs and paving which are within 5 feet of new trees as noted and detailed on drawings.
- B. Install Root Deflector to a minimum of 18 inches deep.

3.7 INITIAL WEED CONTROL

- A. Inspect plant beds, lawns, and meadows for the presence of weeds. If weeds are present apply broad spectrum herbicide.
- B. During herbicide application ensure safety and environmental precautions are taken and best management practices are employed. Adjust procedures adjacent to waterways.

3.8 SOIL PREPARATION AND FINISH GRADING

- A. Remove debris, sticks, roots, clods, stones, and soils contaminated by petroleum products at plant beds and lawns. Rake smooth, eliminate uneven areas or low spots in Soil Material, and set grades for positive drainage.
- B. At plant beds:
  - 1. Apply herbicide to remove weeds as described in Initial Weed Control.
  - 2. Spread fertilizer over the plant bed as recommended by the Soil Material test results.
  - 3. Spread 3 inches Organic Material over entire plant bed. Organic Material must be incorporated immediately into plant beds, no stock piling is permitted.
  - 4. Notify Owner's Representative for Organic Material Placement Review prior to proceeding with tilling and planting.
  - 5. Thoroughly rototill Organic Material and amendments into the top 6 inches of Soil Material, except within Tree Protection fencing where plants will be pocket planted.
  - 6. Rake smooth and reset finish grades eliminating uneven or low spots in plant beds and setting grades for positive drainage. Ensure grades at edges of plant beds allow for placement of Mulch Material to specified depths and as detailed.
  - 7. Spread biological amendments.
- C. At trees:
  - 1. Thoroughly mix 5 parts Soil Material and 1 part Organic Material for backfilling trees.
- D. At lawns: refer to sod specifications
- E. At lawn repair areas: refer to sod specifications.
- F. Notify Owner's Representative for Finish Grading Review prior to proceeding with Work.

### 3.9 SECOND WEED CONTROL

- A. After completion of Soil Preparation and finish grading commence irrigation of all plant beds and lawns. If weeds are present apply broad spectrum herbicide.
- B. Wait ten days minimum and inspect all plant beds and lawn areas for the presence of any additional weeds. If weeds are present, apply a second application of Herbicide to affected areas and delay planting until all weeds are dead.
- C. During herbicide application ensure safety and environmental precautions are taken and best management practices are employed. Adjust procedures adjacent to waterways.

### 3.10 INSTALLATION OF PLANT MATERIAL

- A. Plant Material Review: Notify Owner's Representative prior to the delivery of all trees and plant materials to the site but prior to installing plants. Owner's Representative will review quality of plant materials and reject plant materials not in compliance to the Plant List and Specifications. This review is preliminary. Final approval of plants materials will not be given until Completion Review.
- B. Plant Material Layout Review: Layout plant material (in containers or B&B) at plant beds for review prior to installation. Notify Owner's Representative for review of plant material layout prior to commencement of planting. The plant material layout review may occur concurrently with the planting mock-up review. Adjust plant materials as directed.
- C. Planting Mock-Up Review: Notify Owner's Representative prior to commencement of planting. Install an initial 1000 square feet sample of typical plantings for review. Adjust planting procedure as directed.
- D. Tree Planting:
  - 1. Soak container grown, B&B, and BR plants before planting.
  - 2. Remove extra soil on top of root ball to expose flare of first buttress root. Root flare must be visible at top of root ball.
  - 3. Dig individual planting holes circular with vertical sides as shown on Planting Detail.
  - 4. Save and thoroughly loosen soil removed from planting hole and use as backfill around tree. Backfill trees with specified mixture if additional Soil Material is needed.
  - 5. Sprinkle mycorrhizal fungi to surface of planting holes at rate of 2-4 ounces per inch of stem caliper.
  - 6. Lift trees by wire basket only. Do not lift trees by trunk or use trunk as a lever to position or move tree.
  - 7. Set B&B trees in the hole with the north marker facing north unless otherwise approved.
  - 8. Set root crown as shown on Planting Detail not less than 3 inches above surrounding finish grade.
  - 9. Cut and completely remove twine and other fasteners from root ball. Remove burlap from top half of root ball. Remove all burlap if not biodegradable. Neatly cut off broken or frayed roots.
  - 10. Remove top half of wire basket after planting.
  - 11. Stake trees as shown on Planting Detail.

E. All other Plants:

1. Soak container grown, B&B, and BR plants before planting.
2. Dig individual planting holes with circular and with vertical sides 1-1/2 inch shallower than depth of root ball.
3. Dig holes for pocket-planted shrubs 3 times the diameter of the rootball.
4. Sprinkle mycorrhizal fungi to surface of planting holes at the following rates:
  - a. #SP4 container - 1 tablespoon
  - b. #1 container - 2 tablespoons
  - c. #3 container - 3 tablespoons
  - d. #5 container - 5 tablespoons
5. Install Planting Tablet at shrubs and ground covers at manufacturer's recommended high rate.
6. Cut circling roots with a sharp knife.
7. Set root crowns 1-1/2 inch above surrounding grade and as detailed.

F. Plants set too deeply will be rejected. Reset plants that have settled.

G. Set Plants plumb and for best appearance.

H. Carefully tamp soil under and around root balls and bare roots to prevent settlement.

I. Backfill pocket-planted plants with equal parts Soil Material and Organic Material.

J. Flood hole when half backfilled and tamp soil between bare roots.

K. Complete backfilling and tamp soil between bare roots.

L. Thoroughly water each plant and entire bed immediately after planting.

M. Remove all tags, labels, strings, etc. from plants.

N. Prune Plant Material to remove dead, broken, or damaged branches.

O. Rake plant beds smooth, resetting finish grades for positive drainage and eliminating uneven or low spots.

3.11 BIOLOGICAL AMENDMENT INSTALLATION

- A. Water apply biological amendments per manufacturer's recommended high rate at plant beds and lawns.

3.12 MULCH INSTALLATION

- A. Install 3 inch minimum depth Mulch within 24 hours after planting at plant beds and trees as shown on drawings and details.

- B. Remove excess Mulch from foliage of plant materials and from bark of trees. Mulch must not be placed within 3 inches of tree trunks. Remove mulch from adjacent surfaces and produce edges shown on Details.

### 3.13 LAWN INSTALLATION

- A. Install lawns with sod unless otherwise noted in documents. When not using sod install with the following method:
  - 1. Hydroseeding:
    - a. Mix seed at required rate, fertilizer, and biological amendments with sufficient hydromulch to keep areas moist during germination and protect seed from wind erosion.
    - b. Ensure all equipment, including hoses, is clean and contains only the specified seed.
- B. Apply water with fine spray immediately after each area is sown.
- C. Provide a temporary barrier at the limits of newly planted lawns.

### 3.14 MAINTENANCE

- A. At Plant Beds during period between installation and Final Completion:
  - 1. Water, fertilize, weed, reset unstable or disturbed plants, and perform other maintenance necessary to assure healthy growth.
  - 2. Install Plant Bed Maintenance Fertilizer as recommended by Soil Testing Agency 45-60 days after installation. Adjust timing for seasonal requirements of plant materials.
  - 3. Thoroughly water immediately after applying Plant Bed Maintenance Fertilizer.
  - 4. Repair and regrade erosion damage.
  - 5. Provide continued weed control and removal until any weed problem is fully eradicated.
- B. At lawns during period between installation and Final Completion:
  - 1. Water, weed, mow, reseed, top dress, and fertilize as necessary to establish a healthy, dense, uniform, weed free stand of grass; maintain at 2 inches high. This includes unirrigated lawns, unless otherwise noted on drawings.
  - 2. Conduct first mowing after grass is firmly rooted and secure. Mow grass when it exceeds 2 inches in height, cutting no more than 1/3 of the grass height at a time. Remove all clippings.
  - 3. Maintain surfaces and supply additional Soil Material and Seed where necessary.
  - 4. After first mowing apply Lawn Maintenance Fertilizer as recommended by Soil Testing agency. Thoroughly water after application.
  - 5. Apply Herbicide (selective) to remove weeds.

3.15 MAINTENANCE AFTER FINAL COMPLETION

- A. Provide maintenance of landscape, plantings, and lawns for a minimum of 90 days after Final Completion. Replace plants that have failed or are in decline at the end of the 90 day period.

3.16 CLEANING

- A. Remove excess materials from site. Protect drain inlets and underground piping as necessary and clean improvements soiled by Work of this Section.

3.17 COMPLETION REVIEW

- A. Notify Owner's Representative for Completion Review when Work of this Section is complete.

END OF SECTION 329000

## SECTION 333100 - SITE SANITARY SEWER SYSTEM

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENT

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division I Specification Section, apply to this Section.

#### 1.2 SECTION INCLUDES

- A. Sanitary sewerage drainage piping, fittings, accessories and bedding.
- B. Connection of building sanitary drainage system to municipal sewers.

#### 1.3 RELATED SECTIONS

- A. Section 312300 - Earthwork.
- B. Section 334100 - Site Storm Sewer System

#### 1.4 REFERENCES

- A. ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. Rammer and 18 inch Drop.
- B. ASTM D3034 - Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

#### 1.5 DEFINITIONS

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

#### 1.6 SUBMITTALS FOR REVIEW

- A. Record location of pipe runs, connections, clean-outs, control points, and invert elevations.
- B. Product Data: Provide data indicating pipe and pipe accessories.

1.7 REGULATORY REQUIREMENTS

- A. Conform to Uniform Plumbing Code for materials and installation of the Work of this section.
- B. Conform to Clean Water Services and Washington County requirements for connection to public sewer mains.

PART 2 - PRODUCTS

2.1 PLASTIC PIPE

- A. ASTM D3034, Type PSM, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter as shown on the drawings, bell and spigot style solvent sealed joint end.

2.2 PIPE ACCESSORIES

- A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.
- B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, clean-outs, reducers, traps and other configurations required.
- C. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Sewer Service" in large letters.

2.3 CLEAN-OUTS

- A. Cleanout Lid and Frame: Cast iron construction, as indicated on drawings.
  - 1. Lid Design: As indicated.
- B. Shaft Construction: Of the same material as the pipe, nominal shaft diameter of eight inches.
- C. Concrete: 3000 psi concrete.

2.4 BEDDING AND BACKFILL MATERIALS

- A. Bedding and Backfill: As specified in Section 312300.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

#### 3.2 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with pipe bedding and backfill material.
- B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

#### 3.3 BEDDING

- A. Excavate pipe trench in accordance with Section 312300 for work of this section. Hand trim excavation for accurate placement of pipe to elevations indicated and provide full support along pipe length.
- B. Place bedding material at trench bottom in accordance with Section 312300, level materials in continuous layers not exceeding 4" compacted per 312300.
- C. Maintain moisture content of bedding material to attain required compaction density.

#### 3.4 INSTALLATION - PIPE

- A. Install pipe, fittings, and accessories in accordance with ASTM D2321 and manufacturer's instructions. Seal joints watertight.
- B. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch.
- C. Install bedding at sides and over top of pipe to placement and compaction requirements of Section 312300.
- D. Refer to Section 312300 for trenching requirements. Do not displace or damage pipe when compacting.
- E. Connect to building sanitary sewer outlet and municipal sewer system.
- F. Install trace wire and colored marker tape continuous over top of pipe; coordinate with Section 312300.

- G. Coordinate the Work with termination of sanitary sewer connection outside building, coordinate connection to municipal sewer with Clean Water Services.

### 3.5 INSTALLATION - CLEAN-OUTS

- A. Form and place cast-in-place concrete pad with provision for sanitary sewer pipe ends.
- B. Establish elevations and inverts for inlets and outlets as indicated.
- C. Mount lid and frame level to elevation indicated.

### 3.6 FIELD QUALITY CONTROL

- A. Request inspection prior to and immediately after placing bedding.
- B. Compaction testing will be performed in accordance with ASTM D1557, ASTM D2922, and ASTM D3017.
- C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
- D. Pressure Test: Test in accordance with the Uniform Plumbing Code, Washington County, Clean Water Services, and Oregon Health Division.

### 3.7 PROTECTION

- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 333100

## SECTION 334100 - SITE STORM SEWER SYSTEM

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENT

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

#### 1.2 SECTION INCLUDES

- A. Site storm sewerage drainage piping, fittings and accessories, and bedding.
- B. Catch basins, area drains, clean-outs, paved area drainage, site surface drainage, and water quality facilities.

#### 1.3 RELATED SECTIONS

- A. Section 312300 - Earthwork: Excavating for sewer system piping.
- B. Section 333100 - Site Sanitary Sewer System

#### 1.4 REFERENCES

- A. ASTM A74 - Cast Iron Soil Pipe and Fittings.
- B. ASTM C14 - Concrete Sewer, Storm Drain, and Culvert Pipe.
- C. ASTM C76 - Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- D. ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- E. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- F. ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb Rammer and 18 inch Drop.
- G. ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- H. ASTM D3034 - Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- I. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- J. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.

## 1.5 SUBMITTALS FOR REVIEW

- A. Product Data: Provide data indicating pipe, pipe accessories, catch basins and cleanouts.

## 1.6 SUBMITTALS AT PROJECT CLOSEOUT

- A. Accurately record actual locations of pipe runs, connections, catch basins, cleanouts, and invert elevations.
- B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

## 1.7 COORDINATION

- A. Coordinate the Work with termination of storm sewer connection outside building, trenching, connection to foundation drainage system, if required, and discharge to sewer or stream.

## 1.8 REGULATORY REQUIREMENTS

- A. Conform to Uniform Plumbing Code for materials and installation of the Work of this section.
- B. Conform to Clean Water Services and Washington County requirements for connection to public sewer mains.

# PART 2 - PRODUCTS

## 2.1 STORM SEWER PIPE MATERIALS

- A. Cast Iron Pipe:
  - 1. ASTM A74, Service type, inside nominal diameter as indicated.
  - 2. Cast Iron Pipe Joint Device: ASTM C564, rubber gasket joint devices.
- B. Concrete Pipe:
  - 1. ASTM C14, Class 3; unreinforced; inside nominal diameter as indicated.
  - 2. Reinforced Concrete Pipe: ASTM C76, Class IV; inside nominal diameter as indicated.
  - 3. Pipe Joint Device: ASTM C443, rubber compression gasket joint.
- C. Plastic Pipe:
  - 1. ASTM D2751, Acrylonitrile-Butadiene-Styrene (ABS) material; inside nominal diameter as indicated, bell and spigot style solvent sealed joint end.

2. ASTM D3034, Type PSM, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter as indicated, bell and spigot style rubber ring sealed gasket joint.

D. Polypropylene Pipe:

1. Smooth lined high-density polyethylene pipe; ADS Sanitite HP, or equal.

2.2 ACCESSORIES

- A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.
- B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.
- C. Filter Fabric: Non-biodegradable, non-woven.
- D. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Storm Sewer Service" in large letters.

2.3 CATCH BASINS, STORMFILTER CATCH BASINS, AREA DRAINS AND DITCH INLETS

- A. Catch Basins: Nyloplast style catch basins or equal.
  1. Lid Design: Round, Standard H-20 in parking areas and drive areas and Pedestrian H-10 as indicated on the drawings.
  2. Nominal Lid and Frame Size: 24 inch.
- B. Storm Filter Catch Basins: Contech Engineered Solutions catch basins. Size, number of cartridges, media and configuration as indicated on the drawings.
- C. Area Drains: Nyloplast, 12" drains or approved equal, square standard or pedestrian hinged lids as indicated on the drawings.
- D. Ditch Inlets: Concrete ditch inlets per drawings.

2.4 CLEANOUTS

- A. Cleanout Lid and Frame: Cast iron construction, as indicated on drawings.
  1. Lid Design: As indicated.
- B. Shaft Construction: Of the same material as the pipe, nominal shaft diameter of eight inches.
- C. Concrete: 3000 psi concrete.

## 2.5 BEDDING AND COVER MATERIALS

- A. Bedding and Backfill: As specified in Section 312300.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

### 3.2 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with pipe bedding and backfill material.
- B. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

### 3.3 BEDDING

- A. Excavate pipe trench in accordance with Section 312300 for work of this section. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 6 inches compacted depth.
- C. Maintain optimum moisture content of bedding material to attain required compaction density.

### 3.4 INSTALLATION - PIPE

- A. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal joints watertight.
- B. Place pipe on minimum four inch deep bedding and backfill material.
- C. Lay pipe to slope gradients noted on drawings with maximum variation from true slope of 1/4 inch. Excavate for pipe bells to provide for uniform support along its full length.
- D. Install aggregate at sides and over top of pipe. Provide top cover to minimum compacted thickness of 12 inches, compact to 92 percent.
- E. Refer to Section 312300 for trenching requirements. Do not displace or damage pipe when compacting.

- F. Not Used.
- G. Connect to building rain drains, municipal storm sewer system, manholes, or discharge.
- H. Install trace wire continuous over top of pipe, below finish grade, above pipe line.

3.5 INSTALLATION - CATCH BASINS, STORMFILTER CATCH BASINS, AREA DRAINS, DITCH INLETS AND CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Support the catch basin on a minimum of six inches of compacted pipe bedding and backfill material.
- C. Level top surface of base pad to assure level top.
- D. Establish elevations and pipe inverts for inlets and outlets as indicated.

3.6 FIELD QUALITY CONTROL

- A. Request inspection prior to and immediately after placing aggregate cover over pipe.
- B. Compaction testing will be performed in accordance with ASTM D1557, ASTM D2922, and ASTM D3017.
- C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.

3.7 PROTECTION

- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

3.8 SCHEDULE

- A. Storm Sewer Main: From 5 feet (1 525 mm) beyond building walls, to municipal sewer or designated outfalls.

END OF SECTION 334100

## **REPORT OF GEOTECHNICAL ENGINEERING SERVICES**

Kaiser K5  
7775 NW Kaiser Road  
Washington County, Oregon

For  
Beaverton School District  
December 14, 2015

GeoDesign Project: BeavSchool-49-01



December 14, 2015

Beaverton School District  
Facilities Development Department  
16550 SW Merlo Road  
Beaverton, OR 97003

Attention: Ms. Jessica Faust

**Report of Geotechnical Engineering Services**

Kaiser K5  
7775 NW Kaiser Road  
Washington County, Oregon  
GeoDesign Project: BeavSchool-49-01

GeoDesign, Inc. is pleased to submit our report of geotechnical engineering services for the proposed Kaiser K5 school. The site is located on the west side of NW Kaiser Road, approximately 2,000 feet (0.4 mile) north of NW Brugger Road, in Washington County, Oregon. Our services for this project were conducted in accordance with our proposal dated July 16, 2015.

We appreciate the opportunity to be of continued service to you. Please call if you have questions regarding this report.

Sincerely,

GeoDesign, Inc.

A handwritten signature in blue ink, appearing to read "G. Saunders", is written over the printed name.

George Saunders, P.E., G.E.  
Principal Engineer

cc: Mr. Monte Higbee, WHPacific, Inc. (via email only)  
Mr. Eric Bolken, DLR Group (via email only)  
Mr. Aaron Olson, Cameron McCarthy (via email only)

VCL:GPS:kt

Attachments

One copy submitted (via email only)

Document ID: BeavSchool-49-01-121415-geor.docx

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## EXECUTIVE SUMMARY

The following is a summary of our findings and our recommendations for design and construction of the proposed school development. This executive summary is limited to an overview of the project. We recommend that the report be referenced for a more thorough description of the subsurface conditions and geotechnical recommendations for the project.

- Based on the assumed foundation loads, the proposed structures can be supported on shallow foundations bearing on firm native soil or soil compacted as structural fill as presented in the “Shallow Foundations” section of this report.
- Significant cuts and fills will be required for the proposed school. Based on the most recent grading plans, cuts will be up to 2.5 feet and fills will be on the order of 10 feet. As discussed in the “Site Preparation” section of this report, moisture conditioning (drying) will be required to use the material as structural fill. In particular, the clayey and silty soil generally present below 5 to 10 feet BGS will be difficult to moisture condition and will be sensitive. Therefore, compaction of the fine-grained silt and clay soil will only be possible during extended dry periods and following moisture conditioning of the soil.
- Based on the current grading plans, the finished grade of the northern majority of the building will be at existing grades or up to 3.5 feet BGS. The finished grade of the southern extension of the building will be up to 8.5 feet above the existing grades. Fill-induced differential settlement between the southern fill and northern cut areas of the building are a consideration. As described in the “Fill-Induced Settlement” section of this report, settlement monitoring points should be installed in southern fill areas to monitor settlement if building connections, slabs, pavements, and other flatwork will be required within three to four weeks of filling to finished grades.
- Cut soil at the site will likely be used as fill in other portions of the site. As described in the “Structural Fill” section of this report, all fill soil needs to be appropriately moisture conditioned and compacted to 92 percent of its maximum dry density. Compaction will result in a “shrinkage factor” of 15 to 25 percent between cut and fill bank yards.
- Our explorations encountered a tilled zone in the upper 8 to 12 inches. In general, the tilled zone is unconsolidated and will provide poor support for foundations, floor slabs, and pavements. We recommend that the tilled zone be improved where cuts are less than 12 inches, as recommended in the “Site Preparation” section of this report.
- The near-surface soil is sensitive to disturbance when at a moisture content that is above optimum. As discussed in the “Construction Considerations” section of this report, the subgrade should be protected from disturbance and damage by construction traffic.

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**ACRONYMS**

## **1.0 INTRODUCTION**

GeoDesign, Inc. is pleased to submit this geotechnical engineering report for the proposed Kaiser K5 school. The site is located on the west side of NW Kaiser Road, approximately 2,000 feet (0.4 mile) north of NW Brugger Road, in Washington County, Oregon. Figure 1 shows the site relative to existing topographic and physical features. Figure 2 shows the proposed site layout and our approximate exploration locations. Acronyms used herein are defined at the end of this document.

### **1.1 PROJECT UNDERSTANDING**

Based on information provided by the project team, including a recent site plan, the new school will be constructed on an approximately 9.87-acre, undeveloped parcel. The plan is to build a new one- to two-story school building in the eastern portion of the site. Parking areas will be constructed north, northwest, and east of the school building. A play field and playground areas are proposed in the west portion of the site, to the west of the building and south of the parent and visitor parking lot. Building foundation loads were provided by DLR Group and indicate maximum column and continuous footing loads will be approximately 239 kips and between 2 and 4 kips per linear foot, respectively. The floor slab loads are anticipated to be less than 100 psf. The site currently consists of a residential house at the northeast corner of the property with several small outbuildings and a gravel driveway extending from NW Kaiser Road. The surrounding area to the west and south of the residential house consists of agricultural fields. The property slopes gently to moderately towards the south to southwest. The southern boundary of the site consists of trees and brush and slopes down to a stream to the south.

Based on the most recent grading plan, we understand that the entrance to the school will be established off of NW Kaiser Road near the northeast portion of the site, with proposed elevations of 309 to 313 feet above MSL. The preliminary proposed finish floor grade of the school is 309.5 feet above MSL. The finished grade of the northern majority of the building will be at existing grades or up to 3.5 feet below existing grades and the finished grade of the southern extension of the building will be up to 8.5 feet above the existing grades. We understand that retaining walls will be constructed along the south portion of the site to heights of up to approximately 6 feet. The development of Washington County P14 roadway at the north boundary of the site, half-street improvements to NW Kaiser Road, and the Tualatin Hills Parks and Recreation pathways proposed at the south portion of the property are currently not included in our scope of work.

### **1.2 BACKGROUND**

We previously completed a slope evaluation (GeoDesign, 2010) of this site in 2010, as part of a larger study that included a total of 75 acres. Our study included a site-specific reconnaissance of the slopes at the south boundary of this site, which were broadly classified as moderately susceptible to landslides in landslide susceptibility maps (Burns and Mickelson, 2009). Our study included reviewing geologic maps, soil mapping with the National Research Conservation Service, evaluation of the LiDAR DEM covering the site vicinity, and a field reconnaissance of the slopes on site. Based on our review and field reconnaissance, we concluded that slopes shallower than 50 percent are stable and do not have a significant susceptibility for shallow-seated landsliding. Although dense vegetation prevented close observation of the steeper slopes at the site, and it is

possible that incised stream banks where the slope exceeds 50 percent could be potentially unstable, the slope gradient map shows that the slopes exceeding 50 percent are mainly located along the heads of the incised stream drainage to the west of the proposed school property boundary. In addition, given these incised stream drainages generally reach heights of only 10 to 15 feet, our report concluded that it was likely that riparian buffers required around the stream drainages crossing the site will provide sufficient setback to mitigate any slope stability concerns. Our report also concluded that deep-seated landsliding is not likely at the site. We did not observe any evidence of recent deep-seated landsliding during our field reconnaissance, such as steep head or internal scarps or back-rotated trees.

We have also completed geotechnical reports for BSD facilities and residential subdivision developments in the area. The BSD facilities we were involved with include the Brugger Road K-8 School (GeoDesign, 2007) and a fatal flaw report for the Joss property (GeoDesign, 1998) to the west of the site. Subsurface conditions encountered in our previous studies included silt and clay underlain by bedrock.

## **2.0 SCOPE OF SERVICES**

The purpose of our geotechnical engineering services was to characterize site subsurface conditions and provide geotechnical engineering recommendations for use in design and construction of the proposed development. Our scope of work included the following:

### **Geotechnical Exploration**

- Reviewed readily available published geologic data and our in-house files for existing information on subsurface conditions in the site vicinity.
- Completed the following explorations:
  - Drilled four borings to depths ranging from 31.5 to 73.0 feet BGS.
  - Excavated eight test pit explorations to a depth of 6.0 feet BGS.
  - Performed one CPT to a depth of approximately 54 feet BGS. Conducted shear wave velocity testing at 1-meter intervals to a depth of approximately 49 feet BGS.
- Classified the materials encountered in the boring and test pit explorations, and maintained a detailed log of each boring and test pit exploration.
- Completed laboratory analyses on disturbed and undisturbed soil samples obtained from the boring and test pit explorations as follows:
  - Nineteen moisture content determinations in general accordance with ASTM D 2216
  - Three Atterberg limits tests in general accordance with ASTM D 4318
  - One consolidation test in general accordance with ASTM D 2435
- Developed 20-year pavement designs for car and bus loads.
- Provided recommendations for site preparation and grading, including demolition, temporary and permanent slopes, fill placement criteria, suitability of on-site soil for fill, subgrade preparation, and recommendations for wet weather construction.
- Provided foundation support recommendations for the proposed structure. Our recommendations include preferred foundation type, allowable bearing capacity, and lateral resistance parameters.
- Provided recommendations for use in design of conventional retaining walls, including backfill and drainage requirements and lateral earth pressures.

- Evaluated groundwater conditions at the site, and provided general recommendations for dewatering during construction and subsurface drainage.
- Provided recommendations for seismic design factors in accordance with the procedures outlined in the 2012 IBC and 2014 SOSSC.
- Prepared this geotechnical engineering report that presents our findings, conclusions, and recommendations.

### **Site-Specific Seismic Evaluation**

The 2014 SOSSC requires a seismic hazard investigation for "special occupancy structures." Special occupancy structures include "buildings for every public, private or parochial school through secondary level or day care centers with a capacity greater than 250 individuals." Our work included a seismic hazard investigation. The specific scope of our services is summarized as follows:

- Reviewed available seismic hazard maps, published dynamic soil properties in the vicinity, and geologic maps and geotechnical reports discussing subsurface conditions.
- Evaluated design-level base rock motions at the site using both probabilistic and deterministic methods.
- Selected and modified existing analogous earthquake records to model expected base rock motions.
- Modeled the soil response at the site using the computer program EZFrisk, and conducted sensitivity analyses of model parameters (including soil properties, soil thicknesses, and base rock motions).
- Provided response spectra at the ground surface and primary foundation elevations, as well as peak ground accelerations.
- Evaluated liquefaction potential and other pertinent and code-identified hazards and their potential effect on the proposed development.

## **3.0 SITE CONDITIONS**

### **3.1 GEOLOGIC SETTING**

The site is located in the Tualatin Basin of the Puget Sound-Willamette Valley physiographic province, a tectonically active lowland located along the convergent Cascadia margin (Orr and Orr, 1999). The Tualatin Basin is formed by a gentle syncline between the uplifted Coast Ranges to the west, the Chehalem Mountains to the south, and the Tualatin Mountains to the north and east. The Tualatin Mountains have been uplifted along northwesterly oriented faults (including the steeply dipping Portland Hills fault located along the eastern flank of the mountains).

The near-surface geologic unit mapped at the site is the fine-grained facies of the Quaternary flood deposits (Madin, 1990). The unit consists of unconsolidated silt, clay, and sand deposited by catastrophic floods associated with the sudden release of waters from glacial Lake Missoula during the late Pleistocene. Several dozen of these Missoula Floods occurred between approximately 15,500 and 12,500 years ago (and perhaps during earlier glaciations). Flood waters several hundred feet deep swept out of the Columbia Gorge and over the lowlands of the Portland area. Thickness of the flood deposits in the site vicinity is approximately 30 feet.

Underlying the flood deposits is a thick accumulation of moderately to poorly lithified mudstone and sandstone mapped as the Sandy River Mudstone equivalent (Madin, 1990). These were deposited in a large delta where the ancient Columbia and Willamette rivers converged, probably during the middle Miocene to Pleistocene (approximately 6 million to 1 million years ago). Thickness of the unit in the site vicinity is approximately 120 feet based on water supply well reports near the site available by OWRD.

Basement rocks underlying the Sandy River Mudstone equivalent in the site vicinity consist of the Miocene Columbia River Basalts, emplaced approximately 17 million to 6 million years ago in the Portland area (Madin, 1990). The Columbia River Basalts are exposed in the Tualatin Basin in the highlands surrounding the valley and in a group of mountains south of the site, which include Cooper Mountain and Bull Mountain. The Columbia River Basalts consist of thick flows of basalt erupted from fissures in eastern Oregon, Washington, and western Idaho that traveled down the ancient Columbia River Gorge to fill the lowland areas around Portland.

### **3.2 SURFACE CONDITIONS**

The site is situated on agricultural farmland consisting predominantly of plowed fields with rows of tall grass. The site is bordered along the eastern perimeter by NW Kaiser Road and on the south perimeter by a moderately steep slope down towards a small stream. The stream corridor consists of trees and brush. The agricultural land extends beyond the west boundary of the proposed development area. A residential dwelling exists on the northeast portion of the development area, adjacent to NW Kaiser Road. The site slopes gently to moderately downward from northeast to southwest with elevations varying between approximately 312 feet above MSL on the northeastern perimeter to 290 feet above MSL along the southern perimeter of the proposed development area.

We conducted a geological reconnaissance of the stream embankment area at the south boundary of the site. The stream slopes were heavily vegetated with blackberry brush and trees. We did not observe any visible signs of slope instability such as bent tree trunks or sloughing or cracking at the top of the embankments. There was a footpath that extended through the brush partway up the embankment. In addition, a roadway extends in the east-west direction on the north side of the stream bank. Generally, our observations were in agreement with those documented in our previous study and described in the “Background” section of this report.

### **3.3 SUBSURFACE CONDITIONS**

#### **3.3.1 General**

We explored subsurface conditions at the site by drilling four borings (B-1 through B-4) to depths ranging from 31.5 to 73.0 feet BGS, excavating eight test pits (TP-1 through TP-8) to a depth of 6.0 feet BGS, and performing one CPT exploration (CPT-1) to a depth of approximately 54 feet BGS (refusal). The approximate exploration locations are shown on Figure 2. The boring logs, test pit logs, and laboratory test results are presented in Appendix A. The CPT log is presented in Appendix B.

Our explorations generally encountered a tilled zone underlain by silt and clay. The silt and clay is underlain by bedrock. The following sections summarize the subsurface units encountered.

### **3.3.2 Root and Tilled Zone**

The surface 8 to 12 inches of soil generally consists of topsoil that has been tilled for agricultural purposes and includes an approximately 3-inch-thick root zone.

### **3.3.3 Fill**

We encountered 12 inches of gravel fill at the surface of boring B-1, which was drilled within the former residential driveway.

### **3.3.4 Silt and Clay**

We encountered silt with varying amounts of clay and clay with varying amounts of silt to the maximum depths of borings B-1 through B-3 and to a depth of 70.0 feet BGS in boring B-4. The silt and clay is generally medium stiff to stiff with some interbedded very soft to soft layers. Laboratory testing on selected samples of the silt and clay indicates the moisture contents varied from approximately 10 to 30 percent at the time of our explorations.

### **3.3.5 Decomposed Bedrock**

We encountered decomposed bedrock at a depth of 70.0 feet BGS in boring B-4. The decomposed bedrock consists of very dense, clayey gravel that resulted in drilling refusal at 73.0 feet BGS. CPT-1 also encountered refusal at a depth of approximately 54 feet BGS, likely on decomposed bedrock.

### **3.3.6 Groundwater**

Groundwater could not be directly observed in the borings due to the mud rotary drilling techniques used. Groundwater was not observed in our CPT probe exploration, which was completed at a depth of approximately 54 feet BGS. Based on available well reports from OWRD, the static groundwater level was recorded at a nearby residence south of the site at a depth of 71 feet BGS. During the wet season, perched water may be present within a few feet of the ground surface. The depth to groundwater may fluctuate in response to seasonal changes, prolonged rainfall, changes in surface topography, and other factors not observed in this study.

## **4.0 CONCLUSIONS AND RECOMMENDATIONS**

Based on the results of our subsurface explorations and engineering analyses, it is our opinion that the site can be developed as proposed. The primary geotechnical considerations for the project are summarized in the Executive Summary. Our specific recommendations are provided in the following sections of this report.

## **5.0 DESIGN**

### **5.1 GENERAL**

The following sections provide our design recommendations for the project. All site preparation and structural fill should be prepared as recommended in the "Construction" section of this report.

## **5.2 SHALLOW FOUNDATIONS**

### **5.2.1 General**

Based on the results of our explorations and analysis, the proposed school building and other small structures associated with the proposed school can be supported by conventional spread footings resting on undisturbed native soil or structural fill overlying firm native soil. As described in the "Fill-Induced Settlement" section of this report, settlement monitoring points should be installed in southern fill areas to monitor settlement if building connections, slabs, pavements and other flatworks will be required within three to four weeks of filling to finished grades.

Foundations should not be established on unimproved tilled zones or any undocumented fills that could be present in association with the existing residence at the northeast portion of the site. Removed material should be replaced with structural fill as described in the "Structural Fill" section of this report. Based on our explorations and the current grading plan, fine-grained silt and clay will be present at the base of the footings. Accordingly, we recommend a minimum of 3 inches of gravel be placed in the base of all footings after evaluation of the subgrade by GeoDesign and prior to forming and rebar placement regardless of the time of year construction occurs. During extended wet weather the gravel thickness should be increased to between 6 and 12 inches.

### **5.2.2 Dimensions and Capacities**

Continuous wall and isolated spread footings should be at least 18 and 24 inches wide, respectively. The bottom of exterior footings should be at least 18 inches below the lowest adjacent exterior grade. The bottom of interior footings should be established at least 12 inches below the base of the slab.

Footings bearing on subgrade prepared as recommended above should be sized based on an allowable bearing pressure of 2,500 psf. This is a net bearing pressure; the weight of the footing and overlying backfill can be ignored in calculating footing sizes. The recommended allowable bearing pressure applies to the total of dead plus long-term live loads and may be increased by 50 percent for short-term loads such as those resulting from wind or seismic forces.

### **5.2.3 Resistance to Sliding**

Lateral loads on footings can be resisted by passive earth pressure on the sides of the structures and by friction on the base of the footings. Our analysis indicates that the available passive earth pressure for footings confined by native soil and structural fill is 250 pcf, modeled as an equivalent fluid pressure. Adjacent floor slabs, pavements, or the upper 12-inch depth of adjacent unpaved areas should not be considered when calculating passive resistance. In addition, in order to rely on passive resistance, a minimum of 10 feet of horizontal clearance must exist between the face of the footings and any adjacent down slopes.

For footings in contact with native soil, a coefficient of friction equal to 0.30 may be used when calculating resistance to sliding. For footings in contact with the granular footing pads, a coefficient of friction equal to 0.40 may be used when calculating resistance to sliding.

#### **5.2.4 Subgrade Observation**

All footing and floor subgrades should be evaluated by a representative of GeoDesign to evaluate the bearing conditions. Observations should also confirm that all loose or soft material, organics, unsuitable fill, prior topsoil zones, and softened subgrades (if present) have been removed. Localized deepening of footing excavations may be required to penetrate any deleterious material.

#### **5.3 FLOOR SLABS**

Satisfactory subgrade support for building floor slabs supporting up to 100 psf areal loading can be obtained on the existing undisturbed native silt or on structural fill. To help reduce moisture transmission and slab shifting, we recommend a minimum 6-inch-thick layer of floor slab base rock be placed and compacted over a subgrade that has been prepared in conformance with the "Site Preparation" section of this report. The floor slab base rock should meet the requirements in the "Structural Fill" section of this report and be compacted to at least 95 percent of ASTM D 1557.

While groundwater is unlikely to be encountered within the slab subgrade material, the native soil is fine-grained and will tend to maintain a high moisture content. In the areas where moisture-sensitive floor slab and flooring will be installed, the installation of a vapor barrier is warranted in order to reduce the potential for moisture transmission through, and efflorescence growth on, the slab and flooring. In addition, flooring manufacturers often require vapor barriers to protect flooring and flooring adhesives and will warrant their product only if a vapor barrier is installed according to their recommendations.

With the exception of the southern end of the building, the finished floor grade will be established at up to 3.5 feet below the existing grades. We recommend that a vapor barrier be installed in all floor slab areas established less than 1 foot above existing grade. Several vapor barrier options are available. If Stego Wrap, or other system where the floor slab concrete is directly over the vapor barrier, is being considered, we recommend that the structural engineer be contacted to determine if the mix design for the concrete should be modified assuming the above-referenced construction sequence. Actual selection and design of an appropriate vapor barrier, if needed, should be based on discussions among members of the design team.

Slabs should be reinforced according to their proposed use and per the structural engineer's recommendations. Load-bearing concrete slabs may be designed assuming a modulus of subgrade reaction,  $k$ , of 125 psi per inch.

#### **5.4 FILL-INDUCED SETTLEMENT**

The finished grade of the northern majority of the building will be at existing grades or up to 3.5 feet below existing grades and the finished grade of the southern extension of the building will be up to 8.5 feet above the existing grades. Grades will also be raised up to 10 feet in the adjacent covered play area.

To control differential settlement between the southern fill and northern cut areas of the building, we recommend a three- to four-week preload period to allow for the majority of the fill-induced settlements to occur prior to establishing the structural connections. The fill extending

south of the building should be built to finished grade at least 40 feet beyond the building footprint during the preload period. Provided a three- to four-week preload period can elapse between achieving final grades and structural connection to the foundation elements, total post-construction building settlement should be less than approximately 1.5 inches and differential settlement between adjacent foundation elements should be less than ½ inch.

We anticipate that settlement of utilities and pavement surfaces will be less than ½ inch after fills are allowed to settle approximately three to four weeks. If grading plans or structural loads change, or the minimum recommended period for settlement to occur is not completed, we should be contacted to perform additional settlement analyses. The above-referenced settlement periods can be shortened by monitoring the settlement. Monitoring of the fill-induced settlements can be achieved as described below.

### **5.5 SETTLEMENT MONITORING**

If settlement monitoring will be required as discussed above, then at least three settlement plates should be installed where fill heights exceed 4.0 feet in height. We request that GeoDesign establish the number and location of the settlement plates based on review of the final grading plans.

A typical settlement plate detail is shown on Figure 3. For ease in handling, the casing and rod portions of the settlement plate are usually installed in 5-foot sections. As filling progresses, couplings are used to install additional sections. Continuity in the monitoring data is maintained by reading and recording the top of the measurement rod immediately prior to and following the addition of new sections. Care must be taken during fill construction not to bend or break the rods.

The settlement plates should be installed prior to site filling and immediately surveyed. Survey shots should be taken at each settlement plate at least twice per week during fill construction and for at least one month after fill construction, followed by once weekly thereafter. The settlement plates should be monitored using survey equipment with accuracy of 1/100<sup>th</sup> of a foot and referenced to a stationary datum established at least 500 feet from the edge of the surcharge area. In addition to recording the elevation of the settlement plates during each survey event, a complete record of the fill placement history requires reading and recording the fill height at each settlement plate. The survey data should be supplied to GeoDesign within three days of the survey. We will provide a Microsoft Excel spreadsheet to the surveyors that can be used to transfer data via email.

### **5.6 RETAINING STRUCTURES**

#### **5.6.1 Assumptions**

We understand that walls up to approximately 6 feet tall are proposed at the south portion of the site to retain grade changes. Our retaining wall design recommendations are based on the following assumptions: (1) the walls consist of conventional, cantilevered retaining walls, (2) the walls are less than 8 feet in height, (3) the backfill is drained, and (4) the backfill has a slope flatter than 4H:1V. Re-evaluation of our recommendations will be required if the retaining wall design criteria for the project varies from these assumptions.

### **5.6.2 Wall Design Parameters**

For unrestrained retaining walls, an active pressure of 35 pcf equivalent fluid pressure should be used for design. For embedded building walls, a superimposed seismic lateral force should be calculated based on a dynamic force of  $6.5H^2$  pounds per lineal foot of wall, where  $H$  is the height of the wall in feet, and applied a distance of  $0.6H$  from the base of the wall. Where retaining walls are restrained from rotation prior to being backfilled, a pressure of 55 pcf equivalent fluid pressure should be used for design.

If surcharges (e.g., retained slopes, building foundations, vehicles, steep slopes, terraced walls, etc.) are located within a horizontal distance from the back of a wall equal to twice the height of the wall, then additional pressures will need to be accounted for in the wall design. Our office should be contacted for appropriate wall surcharges based on the actual magnitude and configuration of the applied loads.

The base of the wall footing excavations should extend a minimum of 18 inches below lowest adjacent grade. The footing excavations should then be lined with a minimum 6-inch-thick layer of compacted imported granular material, as described in the “Materials” section of this report.

The wall footings should be designed in accordance with the guidelines provided in the appropriate portion of the “Shallow Foundations” section of this report.

### **5.6.3 Wall Drainage and Backfill**

The above design parameters have been provided assuming that back-of-wall drains will be installed to prevent buildup of hydrostatic pressures behind all walls. If a drainage system is not installed, then our office should be contacted for revised design forces.

The backfill material placed behind the walls and extending a horizontal distance of  $\frac{1}{2}H$ , where  $H$  is the height of the retaining wall, should consist of retaining wall select backfill placed and compacted in conformance with the “Structural Fill” section of this report.

A minimum 6-inch-diameter perforated collector pipe should be placed at the base of the walls. The pipe should be embedded in a minimum 2-foot-wide zone of angular drain rock that is wrapped in a drainage geotextile fabric and extends up the back of the wall to within 1 foot of the finished grade. The drain rock and drainage geotextile fabric should meet specifications provided in the “Materials” section of this report. The perforated collector pipes should discharge at an appropriate location away from the base of the wall. The discharge pipe(s) should not be tied directly into stormwater drain systems, unless measures are taken to prevent backflow into the drainage system of the wall.

Settlement of up to 1 percent of the wall height commonly occurs immediately adjacent to the wall as the wall rotates and develops active lateral earth pressures. Consequently, we recommend that construction of flatwork adjacent to retaining walls be postponed at least four weeks after backfilling of the wall, unless survey data indicates that settlement is complete prior to that time.

## 5.7 SEISMIC DESIGN CONSIDERATIONS

### 5.7.1 IBC Parameters

Based on our explorations, the following design parameters can be applied if the building is designed using the applicable provisions of the 2012 IBC and 2014 SOSSC. The parameters in Table 1 are appropriate for code-level seismic design. We performed a site-specific seismic study for this project. The results of this study, including liquefaction analyses, are presented in Appendix C. As discussed in Appendix C, liquefaction will not present a design concern for the project.

**Table 1. IBC Seismic Design Parameters**

Seismic Design Parameter	Short Period ( $T_s = 0.2$ second)	1 Second Period ( $T_1 = 1.0$ second)
MCE Spectral Acceleration, $S$	$S_s = 1.03$ g	$S_1 = 0.45$ g
Site Class	D	
Site Coefficient, $F$	$F_a = 1.09$	$F_v = 1.55$
Adjusted Spectral Acceleration, $S_M$	$S_{MS} = 1.12$ g	$S_{M1} = 0.70$ g
Design Spectral Response Acceleration Parameters, $S_D$	0.75 g	0.46 g
Design Spectral PGA	0.30 g	

## 5.8 PAVEMENTS

### 5.8.1 Design Assumptions and Parameters

Traffic at the proposed school facility will consist primarily of passenger cars and buses. At the time this report was prepared we had not been provided with anticipated traffic counts. We anticipate that AC pavements will be used for passenger car drive aisles and parking areas. Bus traffic areas could consist of either AC or PCC. Pavements should be installed on undisturbed native subgrade, scarified and re-compacted soil, or new engineered fills described in the "Site Preparation" and "Structural Fill" sections of this report. If near-surface soil is cement amended, we should be contacted to revise our recommendations.

Our pavement recommendations are based on the following assumptions:

- 20-year design life for AC and PCC.
- A resilient modulus of 20,000 psi was estimated for the aggregate base.
- Initial and terminal serviceability indices of 4.2 and 2.0 for AC and 4.5 and 2.5 for PCC pavement.
- Reliability and standard deviations of 85 percent and 0.45 for AC pavement and 85 percent and 0.40 for PCC pavement.
- Structural coefficient of 0.42 and 0.10 for the asphalt and aggregate base, respectively.

- The number of buses and trucks indicated below, plus trucks are assumed to be 50 percent two-axle and 50 percent three-axle trucks. We have not included a growth factor. Analysis of alternative traffic assumptions can be completed if requested.
- A resilient modulus of 4,500 psi and an effective k-value of 150 psi per inch for native or fill subgrade prepared in accordance with the “Site Preparation” portion of the report.

If any of these assumptions are incorrect, our office should be contacted with the appropriate information so that the pavement designs can be revised.

### 5.8.2 Flexible AC Pavement Recommendations

Based on the traffic assumptions provided above, we recommend the AC pavement sections in Table 2.

**Table 2. Recommended Standard Pavement Sections**

Pavement Use	Busses per Day	Trucks per Day <sup>1</sup>	ESALs	AC Thickness (inches)	Aggregate Base Thickness (inches)
Automobile-Only Drive Aisles	0	0	50,000	3.0	10.0
Automobile Parking	0	0	10,000	2.5	9.0
Bus Areas	10	10	103,000	4.0	12.0
	20	10	161,000	4.5	12.0
	30	10	219,000	4.5	13.0

Trucks assumed to be 50 percent two-axle and 50 percent three-axle trucks.

If the subgrade is cement amended to the thicknesses indicated below and the amended soil achieves a seven-day unconfined compressive strength of at least 100 psi, then the pavements can be constructed as recommended in Table 3.

**Table 3. Recommended Pavement Sections Using Cement Amendment**

Pavement Use	Busses per Day	Trucks per Day <sup>1</sup>	ESALs	AC Thickness (inches)	Aggregate Base Thickness (inches)	Cement Amendment <sup>2</sup> (inches)
Automobile-Only Drive Aisles	0	0	50,000	3.0	4.0	12.0
Automobile Parking	0	0	10,000	2.5	4.0	12.0
Bus Areas	10	10	103,000	4.0	4.0	12.0
	20	10	161,000	4.5	5.0	12.0
	30	10	219,000	4.5	6.0	12.0

1. Trucks assumed to be 50 percent two-axle and 50 percent three-axle trucks.
2. Assumes a minimum seven-day unconfined compressive strength of 100 psi.

All thicknesses are intended to be the minimum acceptable. The design of the recommended pavement section is based on the assumption that construction will be completed during an extended period of dry weather. Wet weather construction could require an increased thickness of aggregate base. In addition, to prevent strength loss during curing, cement-amended soil should be allowed to cure for at least four days prior to construction traffic or placing the base rock. Lastly, the amended subgrade should be protected with a minimum of 4 inches of base rock prior to construction traffic access.

Construction traffic should be limited to non-building, unpaved portions of the site or haul roads. Construction traffic should not be allowed on new pavements. If construction traffic is to be allowed on newly constructed road sections, an allowance for this additional traffic will need to be made in the design pavement section.

The AC, aggregate base, and cement amendment should meet the requirements outlined in the "Materials" section of this report.

## **5.9 DRAINAGE**

### **5.9.1 General**

The finished grade of the northern majority of the building will be at existing grades or up to 3.5 feet below existing grades and the finished grade of the southern extension of the building will be up to 8.5 feet above the existing grades. Perched groundwater is typically encountered in the fine-grained soil at the site.

### **5.9.2 Surface**

Where possible, the finished ground surface around the buildings should be sloped away from the structures at a minimum 2 percent gradient for a distance of at least 5 feet. Downspouts or roof scuppers should discharge into a storm drain system that carries the collected water to an

appropriate stormwater system. Trapped planter areas should not be created adjacent to the buildings without providing means for positive drainage (e.g., swales or catch basins).

### **5.9.3 Foundation Drains**

We recommend that perimeter foundation drains be installed where the finished floor grade will be less than 2 feet above existing grades. The foundation drains should be constructed at a minimum slope of approximately ½ percent and pumped or drained by gravity to a suitable discharge. The perforated drainpipe should not be tied to a stormwater drainage system without backflow provisions. The foundation drains should consist of 4-inch-diameter perforated drainpipe embedded in a minimum 2-foot-wide zone of crushed drain rock that extends to the ground surface. The invert elevation of the drainpipe should be installed at least 18 inches below the elevation of the floor slab. The drain rock and geotextile should meet the requirements specified in the “Materials” section of this report. The drain rock and geotextile should extend up the side of embedded walls to within a foot of the ground surface, geotextile wrapped over the top of the drain rock, as recommended in the “Retaining Structures” section of this report.

## **6.0 CONSTRUCTION**

### **6.1 SITE PREPARATION**

#### **6.1.1 Demolition**

Site development will include demolition and removal of existing structures or utilities that may be present underneath areas to be improved. Demolition includes complete removal of any remaining building walls, concrete slabs, and footings. Abandoned foundations and utilities, if present, will need to be removed and the resulting excavations backfilled. All prior or existing septic systems should be removed. We understand a water well is present on site, and it should be decommissioned in accordance with OWRD requirements. Drain tiles, if present within building and fill areas, should also be removed.

In general, demolished material should be transported off site for disposal. Demolished asphalt and concrete may be used in structural fill, provided it can be processed or crushed to meet the requirements provided in the “Structural Fill” section of this report.

Excavations left from demolition and removal of existing structures should be backfilled with compacted structural fill in accordance with recommendations in the “Materials” section of this report.

#### **6.1.2 Stripping and Grubbing**

The existing topsoil zone should be stripped and removed from all fill areas. Based on our explorations, the average depth of stripping will be approximately 3 inches, although greater stripping depths may be required to remove localized zones of loose or organic soil. The actual stripping depth should be based on field observations at the time of construction. Stripped material should be transported off site for disposal or used in landscaped areas.

Trees and shrubs should be removed from fill areas. In addition, root balls should be grubbed out to the depth of the roots, which could exceed 3 feet BGS. Depending on the methods used

to remove the root balls, considerable disturbance and loosening of the subgrade could occur during site grubbing. We recommend that soil disturbed during grubbing operations be removed to expose firm, undisturbed subgrade. The resulting excavations should be backfilled with structural fill.

#### **6.1.3 Tilled/Topsoil Zone**

An approximately 8- to 12-inch-deep agricultural tilled zone was also observed at the ground surface in our explorations. Reliable strength properties are extremely difficult to predict for the tilled zone material. There is a high risk for poor performance of floor slabs and pavements established directly over loosened soil. In order to reduce the risk of settlement, we recommend that the tilled zone be improved during site preparation in areas where less than 12 inches of cuts are planned. Prior to fill placement and construction, the upper 12 inches of subgrade should be improved by removing and replacing with structural fill or scarifying and re-compacting to structural fill requirements.

As discussed in the "Structural Fill" section of this report, the native soil can be sensitive to small changes in moisture content and will be difficult, if not impossible, to compact adequately during wet weather. While scarification and compaction of the subgrade is the best option for subgrade improvement, it will likely only be possible during extended dry periods and following moisture conditioning of the soil. As discussed further on in this report, cement amendment is an option for conditioning the soil for use as structural fill during periods of wet weather or when drying the soil is not an option.

#### **6.1.4 Subgrade Evaluation**

Upon completion of stripping and subgrade stabilization, and prior to the placement of fill or pavement improvements, the exposed subgrade should be evaluated by proof rolling. The subgrade should be proof rolled with a fully loaded dump truck or similarly heavy, rubber-tired construction equipment to identify soft, loose, or unsuitable areas. A member of our geotechnical staff should observe the proof rolling to evaluate yielding of the ground surface. During wet weather, subgrade evaluation should be performed by probing with a foundation probe rather than proof rolling. Areas that appear soft or loose should be improved in accordance with subsequent sections of this report.

#### **6.1.5 Compacting Test Pit Locations**

The test pit excavations were backfilled using the relatively minimal compactive effort of the hoe bucket; therefore, soft spots can be expected at these locations. We recommend that the relatively uncompacted soil be removed from the test pits to a depth of 3 feet below finished subgrade elevation in pavement areas and to full depth in building areas (based on the current site plan, test pits were not located within the proposed building area). The resulting excavation should be backfilled with structural fill.

### **6.2 CONSTRUCTION CONSIDERATIONS**

The fine-grained soil present on this site is easily disturbed. If not carefully executed, site preparation, utility trench work, and excavations can create extensive soft areas and significant repair costs can result. Earthwork planning, regardless of the time of year, should include considerations for minimizing subgrade disturbance.

If construction occurs during or extends into the wet season, or if the moisture content of the surficial soil is more than a couple percentage points above optimum, site stripping and cutting may need to be accomplished using track-mounted equipment. Likewise, the use of granular haul roads and staging areas will be necessary for support of construction traffic during the rainy season or when the moisture content of the surficial soil is more than a few percentage points above optimum. The base rock thickness for pavement areas is intended to support post-construction design traffic loads. This design base rock thickness may not support construction traffic or pavement construction when the subgrade soil is wet. Accordingly, if construction is planned for periods when the subgrade soil is wet, staging and haul roads with increased thicknesses of base rock will be required. The amount of staging and haul road areas, as well as the required thickness of granular material, will vary with the contractor's sequencing of a project and type/frequency of construction equipment. Based on our experience, between 12 and 18 inches of imported granular material is generally required in staging areas and between 18 and 24 inches in haul roads areas. Stabilization material may be used as a substitute provided the top 4 inches of material consists of imported granular material. The actual thickness will depend on the contractor's means and methods and, accordingly, should be the contractor's responsibility. In addition, a geotextile fabric should be placed as a barrier between the subgrade and imported granular material in areas of repeated construction traffic. The imported granular material, stabilization material, and geotextile fabric should meet the specifications in the "Materials" section of this report.

As an alternative to thickened crushed rock sections, haul roads and utility work zones may be constructed using cement-amended subgrades overlain by a crushed rock wearing surface. If this approach is used, the thickness of granular material in staging areas and along haul roads can typically be reduced to between 6 and 9 inches. This recommendation is based on an assumed minimum unconfined compressive strength of 100 psi for subgrade amended to a depth of 12 to 16 inches. The actual thickness of the amended material and imported granular material will depend on the contractor's means and methods and, accordingly, should be the contractor's responsibility. Cement amendment is discussed in the "Materials" section of this report.

### **6.3 PERMANENT SLOPES**

Permanent cut and fill slopes should not exceed 2H:1V. Slopes to be maintained by mowing should not exceed 3H:1V. Access roads and pavements should be located at least 5 feet from the top of cut and fill slopes. The setback for buildings should be increased to 10 feet from top of cut and fill slopes. The current plan shows the southernmost retaining wall located approximately 40 feet from the stream buffer zone at the closest point. The buffer zone is an additional 20 feet from the top of the stream bank. Based on our analysis, this provides adequate setback for overall slope stability. The slopes should be planted with appropriate vegetation to provide protection against erosion as soon as possible after grading. Surface water runoff should be collected and directed away from slopes to prevent water from running down the face of the slope.

## **6.4 EXCAVATION**

### **6.4.1 Excavation and Shoring**

Temporary excavation sidewalls should stand vertical to a depth of approximately 4 feet, provided groundwater seepage is not observed in the sidewalls. Open excavation techniques may be used to excavate trenches with depths between 4 and 8 feet, provided the walls of the excavation are cut at a slope of 1.5H:1V and groundwater seepage is not present. At this inclination, the slopes with loose sand may ravel and require some ongoing repair. Excavations should be flattened if excessive sloughing or raveling occurs. In lieu of large open cuts, approved temporary shoring may be used for excavation support. A wide variety of shoring and dewatering systems are available. Consequently, we recommend that the contractor be responsible for selecting the appropriate shoring and dewatering systems.

If box shoring is used, it should be understood that box shoring is a safety feature used to protect workers and does not prevent caving. If the excavations are left open for extended periods of time, then caving of the sidewalls may occur. The presence of caved material will limit the ability to properly backfill and compact the trenches. The contractor should be prepared to fill voids between the box shoring and the sidewalls of the trenches with sand or gravel before caving occurs.

If shoring is used, we recommend that the type and design of the shoring system be the responsibility of the contractor, who is in the best position to choose a system that fits the overall plan of operation. All excavations should be made in accordance with applicable OSHA and state regulations.

### **6.4.2 Trench Dewatering**

Shallow excavations (less than 5 feet) will not likely encounter groundwater. However, perched groundwater may be encountered after prolonged wet periods. Dewatering systems are best designed by the contractor; however, it is our opinion that it should be possible to remove groundwater encountered by pumping from a sump in the trenches. More intense use of pumps may be required at certain times of the year and where more intense seepage occurs. Removed water should be routed to a suitable discharge point.

If groundwater is present at the base of utility trench excavations, we recommend placing up to 12 inches of stabilization material at the base of the excavations. Trench stabilization material should meet the requirements provided in the "Structural Fill" section of this report.

We note that these recommendations are for guidance only. The dewatering of excavations is the sole responsibility of the contractor, as the contractor is in the best position to select these systems based on their means and methods.

### **6.4.3 Safety**

All excavations should be made in accordance with applicable OSHA requirements and regulations of the state, county, and local jurisdiction. While this report describes certain approaches to excavation and dewatering, the contract documents should specify that the

contractor is responsible for selecting excavation and dewatering methods, monitoring the excavations for safety, and providing shoring (as required) to protect personnel and adjacent structural elements.

## **6.5 MATERIALS**

### **6.5.1 Structural Fill**

#### **6.5.1.1 General**

Fill should be placed on subgrade that has been prepared in conformance with the “Site Preparation” section of this report. A variety of material may be used as structural fill at the site. However, all material used as structural fill should be free of organic matter or other unsuitable material and should meet the specifications provided in OSSC 00330 (Earthwork), OSSC 00400 (Drainage and Sewers), and OSSC 02600 (Aggregates), depending on the application. A brief characterization of some of the acceptable materials and our recommendations for their use as structural fill is provided below.

#### **6.5.1.2 On-Site Soil**

The material at the site should be suitable for use as general structural fill provided it is properly moisture conditioned; free of debris, organic material, and particles over 4 inches in diameter; and meets the specifications provided in OSSC 00330.12 (Borrow Material).

Based on laboratory test results, the moisture content of the on-site soil generally varied from 10 to 30 percent at the time of our explorations. We estimate the optimum moisture content for compaction to be approximately 17 to 19 percent for the on-site soil. Moisture conditioning (primarily drying) will be required to use on-site soil for structural fill. Accordingly, extended dry weather will be required to adequately condition and place the soil as structural fill. It will be difficult, if not impossible, to adequately compact on-site soil during the rainy season or during prolonged periods of rainfall.

When used as structural fill, native soil should be placed in lifts with a maximum uncompacted thickness of 6 to 8 inches and compacted to not less than 92 percent of the maximum dry density for fine-grained soil and 95 percent of the maximum dry density for granular soil, as determined by ASTM D 1557.

#### **6.5.1.3 Imported Granular Material**

Imported granular material used as structural fill should be pit- or quarry-run rock, crushed rock, or crushed gravel and sand and should meet the specifications provided in OSSC 00330.14 (Selected Granular Backfill) or OSSC 00330.15 (Selected Stone Backfill). The imported granular material should also be angular, fairly well graded between coarse and fine material, have less than 5 percent by dry weight passing the U.S. Standard No. 200 Sieve, and have at least two fractured faces.

Imported granular material should be placed in lifts with a maximum uncompacted thickness of 12 inches and compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D 1557. During the wet season or when wet subgrade conditions exists, the initial lift should be approximately 18 inches in uncompacted thickness and should be compacted by rolling with a smooth-drum roller without using vibratory action.

#### **6.5.1.4     *Stabilization Material***

Stabilization material used in staging or haul road areas, or as trench stabilization material, should consist of 4- or 6-inch-minus pit- or quarry-run rock, crushed rock, or crushed gravel and sand and should meet the specifications provided in OSSC 00330.15 (Selected Stone Backfill). The material should have a maximum particle size of 6 inches, less than 5 percent by dry weight passing the U.S. Standard No. 4 Sieve, and at least two mechanically fractured faces. The material should be free of organic matter and other deleterious material. Stabilization material should be placed in lifts between 12 and 24 inches thick and compacted to a firm condition.

#### **6.5.1.5     *Trench Backfill***

Trench backfill placed beneath, adjacent to, and for at least 12 inches above utility lines (i.e., the pipe zone) should consist of well-graded granular material with a maximum particle size of 1½ inches and less than 10 percent by dry weight passing the U.S. Standard No. 200 Sieve and should meet the specifications provided in OSSC 00405.13 (Pipe Zone Material). The pipe zone backfill should be compacted to at least 90 percent of the maximum dry density, as determined by ASTM D 1557, or as required by the pipe manufacturer or local building department.

Within roadway alignments, the remainder of the trench backfill up to the subgrade elevation should consist of well-graded granular material with a maximum particle size of 2½ inches and less than 10 percent by dry weight passing the U.S. Standard No. 200 Sieve and should meet the specifications provided in OSSC 00405.14 (Trench Backfill; Class B, C, or D). This material should be compacted to at least 90 percent of the maximum dry density, as determined by ASTM D 1557, or as required by the pipe manufacturer or local building department. The upper 3 feet of the trench backfill should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D 1557.

Outside of structural improvement areas (e.g., roadway alignments or building pads) trench backfill placed above the pipe zone may consist of general fill material that is free of organics and material over 6 inches in diameter and meets the specifications provided in OSSC 00405.14 (Trench Backfill; Class A, B, C, or D). This general trench backfill should be compacted to at least 90 percent of the maximum dry density, as determined by ASTM D 1557, or as required by the pipe manufacturer or local building department.

#### **6.5.1.6     *Drain Rock***

Drain rock should consist of angular, granular material with a maximum particle size of 2 inches and should meet the specifications provided in OSSC 00430.11 (Granular Drain Backfill Material). The material should be free of roots, organic matter, and other unsuitable material; have less than 2 percent by dry weight passing the U.S. Standard No. 200 Sieve (washed analysis); and have at least two mechanically fractured faces. Drain rock should be compacted to a well-keyed, firm condition.

#### **6.5.1.7     *Aggregate Base Rock***

Imported granular material used as base rock for building floor slabs and pavements should consist of ¾- or 1½-inch-minus material (depending on the application) and meet the requirements in OSSC 00641 (Aggregate Subbase, Base, and Shoulders). In addition, the

aggregate should have less than 5 percent by dry weight passing the U.S. Standard No. 200 Sieve. The base aggregate should be compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D 1557.

#### **6.5.1.8 Retaining Wall Select Backfill**

Backfill material placed behind retaining walls and extending a horizontal distance of  $\frac{1}{2}H$ , where H is the height of the retaining wall, should consist of select granular material that meets the specifications provided in OSSC 00510.12 (Granular Wall Backfill) or OSSC 00510.13 (Granular Structure Backfill).

The backfill should be placed and compacted as recommended for structural fill, with the exception of backfill placed immediately adjacent to walls. Backfill adjacent to walls should be compacted to a lesser standard to reduce the potential for generation of excessive pressure on the walls. Backfill located within a horizontal distance of 3 feet from the retaining walls should be compacted to approximately 90 percent of the maximum dry density, as determined by ASTM D 1557. Backfill placed within 3 feet of the wall should be compacted in lifts less than 6 inches thick using hand-operated tamping equipment (such as a jumping jack or vibratory plate compactor). If flatwork (slabs, sidewalk, or pavement) will be placed adjacent to the wall, we recommend that the upper 2 feet of fill be compacted to 95 percent of the maximum dry density, as determined by ASTM D 1557.

#### **6.5.1.9 Cement Amendment**

##### **General**

In conjunction with an experienced contractor, the on-site soil can be amended with portland cement to obtain suitable support properties. Successful use of soil amendment depends on the use of correct mixing techniques, soil moisture content, and amendment quantities. Soil amending should be conducted in accordance with the specifications provided in OSSC 00344 (Treated Subgrade). The amount of cement used during treatment should be based on an assumed soil dry unit weight of 110 pcf.

##### **Stabilization**

Specific recommendations based on exposed site conditions for soil amending can be provided if necessary. However, for preliminary design purposes, we recommend a target strength for cement-amended subgrade for building and pavement subbase (below base aggregate) soil of 100 psi. The amount of cement used to achieve this target generally varies with moisture content and soil type. It is difficult to predict field performance of soil to cement amendment due to variability in soil response, and we recommend laboratory testing to confirm expectations. Generally, 4 percent cement by weight of dry soil can be used when the soil moisture content does not exceed approximately 20 percent. If the soil moisture content is in the range of 25 to 35 percent, 6 to 8 percent by weight of dry soil is recommended. The amount of cement added to the soil may need to be adjusted based on field observations and performance. Moreover, depending on the time of year and moisture content levels during amendment, water may need to be applied during tilling to appropriately condition the soil moisture content.

For building and pavement subbase, we recommend assuming a minimum cement ratio of 6 percent (by dry weight). If the soil moistures are in excess of 30 percent, a cement ratio of

7 percent will likely be needed. Because of the higher organic content and moisture, we recommend using a cement ratio of 7 to 8 percent when stabilizing tilled zone material for building and pavement subbase.

A minimum curing of four days is required between treatment and construction traffic access. Construction traffic should not be allowed on unprotected cement amended subgrade. To protect the cement-amended surfaces from abrasion or damage, the finished surface should be covered with 4 to 6 inches of imported granular material.

Treatment depths for building/pavement, haul roads, and staging areas are typically on the order of 12, 16, and 12 inches, respectively. The crushed rock typically becomes contaminated with soil during construction. Contaminated base rock should be removed and replaced with clean rock in pavement areas. The actual thickness of the amended material and imported granular material for haul roads and staging areas will depend on the anticipated traffic, as well as the contractor's means and methods, and accordingly, should be the contractor's responsibility.

### **Structural**

On-site soil that would not otherwise be suitable for structural fill may be amended and placed as fill over a subgrade prepared in conformance with the "Site Preparation" section of this report. The cement ratio for general cement amended fill can generally be reduced by 1 percent (by dry weight). Typically, a minimum curing of four days is required between treatment and construction traffic access. Consecutive lifts of fill may be treated immediately after the previous lift has been amended and compacted (e.g., the four-day wait period does not apply). However, where the final lift of fill is a building or roadway subgrade, then the four-day wait period is in effect.

### **Compaction**

A static, sheepsfoot or segment pad roller with a minimum static weight of 40,000 pounds should be used for compaction of fine-grained soil followed by final compaction using a smooth-drum roller with a minimum applied lineal force of 700 pounds per inch. The amended soil should be compacted to at least 92 percent of the achievable dry density at the moisture content of the material as defined by ASTM D 1557.

### **Specifications Recommendations**

We recommend that the following comments be included in the specifications for the project:

- **Mixing Equipment**
  - Use a pulverizer/mixer capable of uniformly mixing the cement into the soil to the design depth. Blade mixing will not be allowed.
  - Pulverize the soil-cement mixture such that 100 percent by dry weight passes a 1 inch sieve and a minimum of 70 percent passes a No. 4 sieve, exclusive of gravel or stone retained on these sieves. If water is required, the pulverizer should be equipped to inject water to a tolerance of ¼ gallon per square foot of surface area.

- Use machinery that will not disturb the subgrade, such as using low-pressure “balloon” tires on the pulverizer/mixer vehicle. If subgrade is disturbed, the tilling/treatment depth shall extend the full depth of the disturbance.
- Multiple “passes” of the tiller will likely be required to adequately blend the cement and soil mixture.
- Spreading Equipment
  - Use a spreader capable of distributing the cement uniformly on the ground to within 5 percent variance of the specified application rate.
  - Use machinery that will not disturb the subgrade, such as using low-pressure “balloon” tires on the spreader vehicle. If subgrade is disturbed, the tilling/treatment depth shall extend the full depth of the disturbance.
- Compaction Equipment
  - Use a static, sheepsfoot or segmented pad roller with a minimum static weight of 40,000 pounds for initial compaction of fine-grained soil (silt and clay), or an alternate approved by the geotechnical engineer.
  - Use a vibratory, smooth-drum roller with a minimum applied lineal force of 600 pounds per inch for final compaction, or an alternate approved by the geotechnical engineer.

#### **6.5.1.10 AC**

The AC should be Level 2, ½-inch, dense ACP and compacted to 91 percent of the theoretical maximum density of the mix, as determined by AASHTO T 209. The minimum and maximum lift thickness should be 2.0 and 3.0 inches, respectively, for ½-inch ACP. Asphalt binder should be performance graded and conform to PG 64-22 or better.

#### **6.5.1.11 Geotextile Fabric**

##### **Subgrade Geotextile Fabric**

A subgrade geotextile fabric should be placed as a barrier between the subgrade and granular material in staging areas, haul road areas, or in areas of repeated construction traffic. The geotextile should meet the specifications provided in OSSC 02320 (Geosynthetics) for separation geotextiles (Table 02320-4) and be installed in accordance with OSSC 00350 (Geosynthetic Installation). The geotextile should have a Level “B” certification.

##### **Drainage Geotextile Fabric**

Drain rock, and other granular material used for subsurface drains, should be wrapped in a geotextile fabric that meets the specifications provided in OSSC 02320 (Geosynthetics) for drainage geotextiles (Table 02320-1) and be installed in accordance with OSSC 00350 (Geosynthetic Installation).

### **6.6 EROSION CONTROL**

The site soil is susceptible to erosion; therefore, erosion control measures should be carefully planned and in place before construction begins. Surface water runoff should be collected and directed away from slopes to prevent water from running down the slope face. Erosion control measures (such as straw bales, sediment fences, and temporary detention and settling basins) should be used in accordance with local and state ordinances.

## **7.0 OBSERVATION OF CONSTRUCTION**

Satisfactory foundation and earthwork performance depends to a large degree on quality of construction. Sufficient observation of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. Subsurface conditions observed during construction should be compared with those encountered during the subsurface exploration. Recognition of changed conditions often requires experience; therefore, qualified personnel should visit the site with sufficient frequency to detect if subsurface conditions change significantly from those anticipated.

We recommend that GeoDesign be retained to observe earthwork activities, including stripping, proof rolling of the subgrade and repair of soft areas, footing subgrade preparation, performing laboratory compaction and field moisture-density tests, observing final proof rolling of the pavement subgrade and base rock, and asphalt placement and compaction.

## **8.0 LIMITATIONS**

We have prepared this report for use by Beaverton School District and members of the design and construction teams for the proposed project. The data and report can be used for bidding or estimating purposes, but our report, conclusions, and interpretations should not be construed as warranty of the subsurface conditions and are not applicable to other nearby building sites.

Exploration observations indicate soil conditions only at specific locations and only to the depths penetrated. They do not necessarily reflect soil strata or water level variations that may exist between exploration locations. If subsurface conditions differing from those described are noted during the course of excavation and construction, re-evaluation will be necessary.

The site development plans and design details were preliminary at the time this report was prepared. When the design has been finalized and if there are changes in the site grades or location, configuration, design loads, or type of construction for the buildings, and walls, the conclusions and recommendations presented may not be applicable. If design changes are made, we request that we be retained to review our conclusions and recommendations and to provide a written modification or verification.

The scope does not include services related to construction safety precautions, and our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in design.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. No warranty, express or implied, should be understood.

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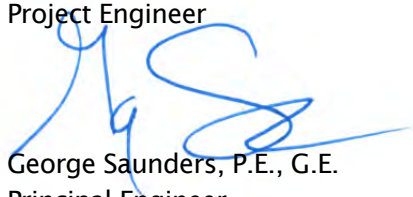
We appreciate the opportunity to be of service to you. Please call if you have questions concerning this report or if we can provide additional services.

Sincerely,

GeoDesign, Inc.



Viola C. Lai, P.E., G.E.  
Project Engineer



George Saunders, P.E., G.E.  
Principal Engineer



## REFERENCES

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Personius, S.F., compiler, 2002, Fault number 877, Portland Hills fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website

## FIGURES

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**GEODESIGN**  
 15575 SW Sequoia Parkway - Suite 100  
 Portland OR 97224  
 Off 503.968.8787 Fax 503.968.3068

BEAVSCHOOL-49-01

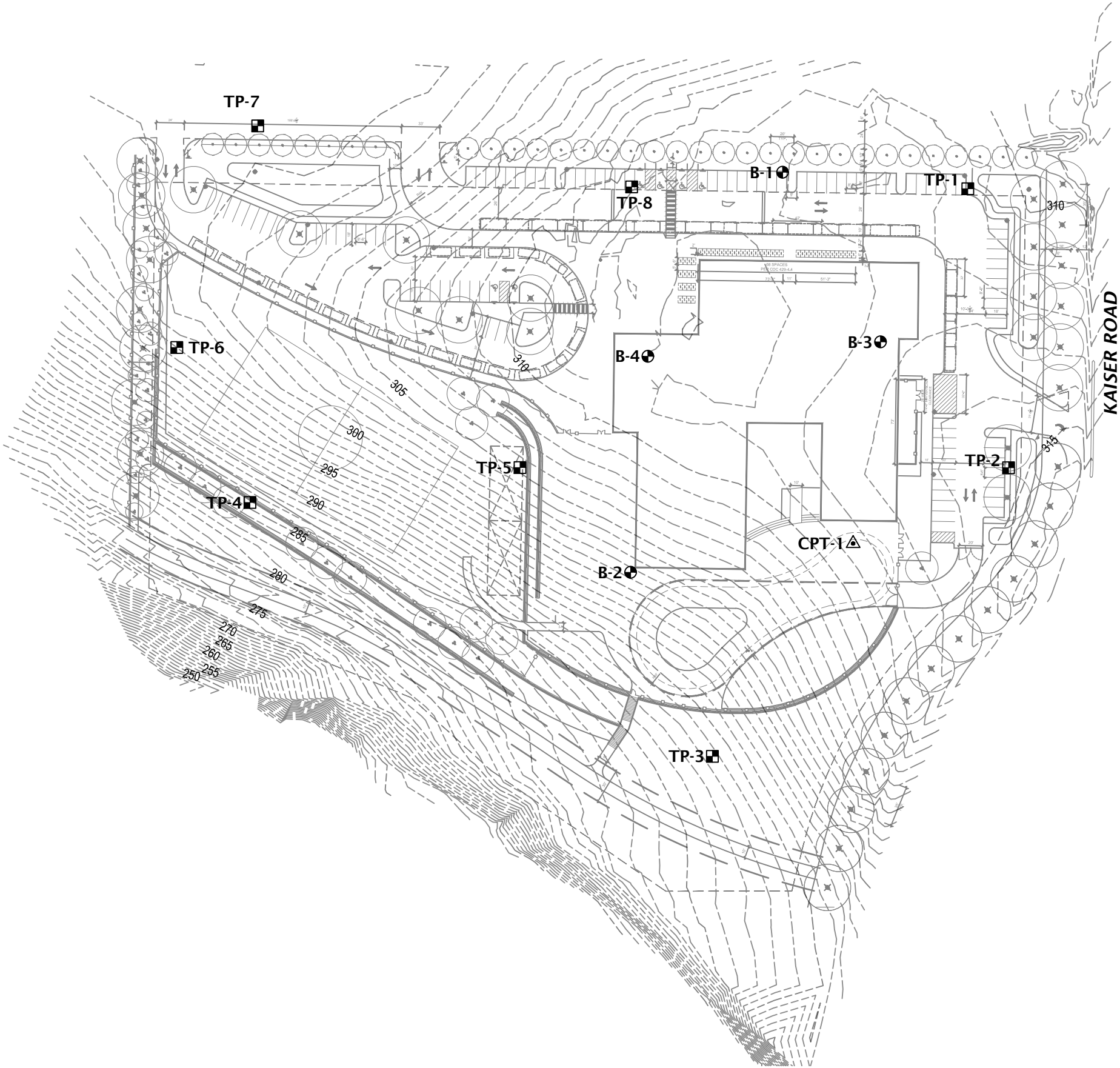
DECEMBER 2015




VICINITY MAP

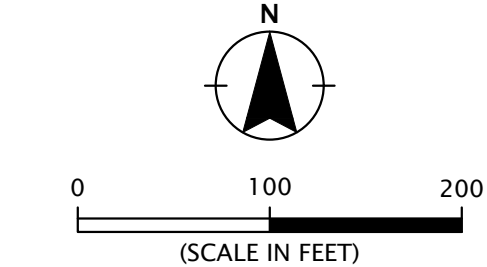
KAISER K5  
 WASHINGTON COUNTY, OR

FIGURE 1


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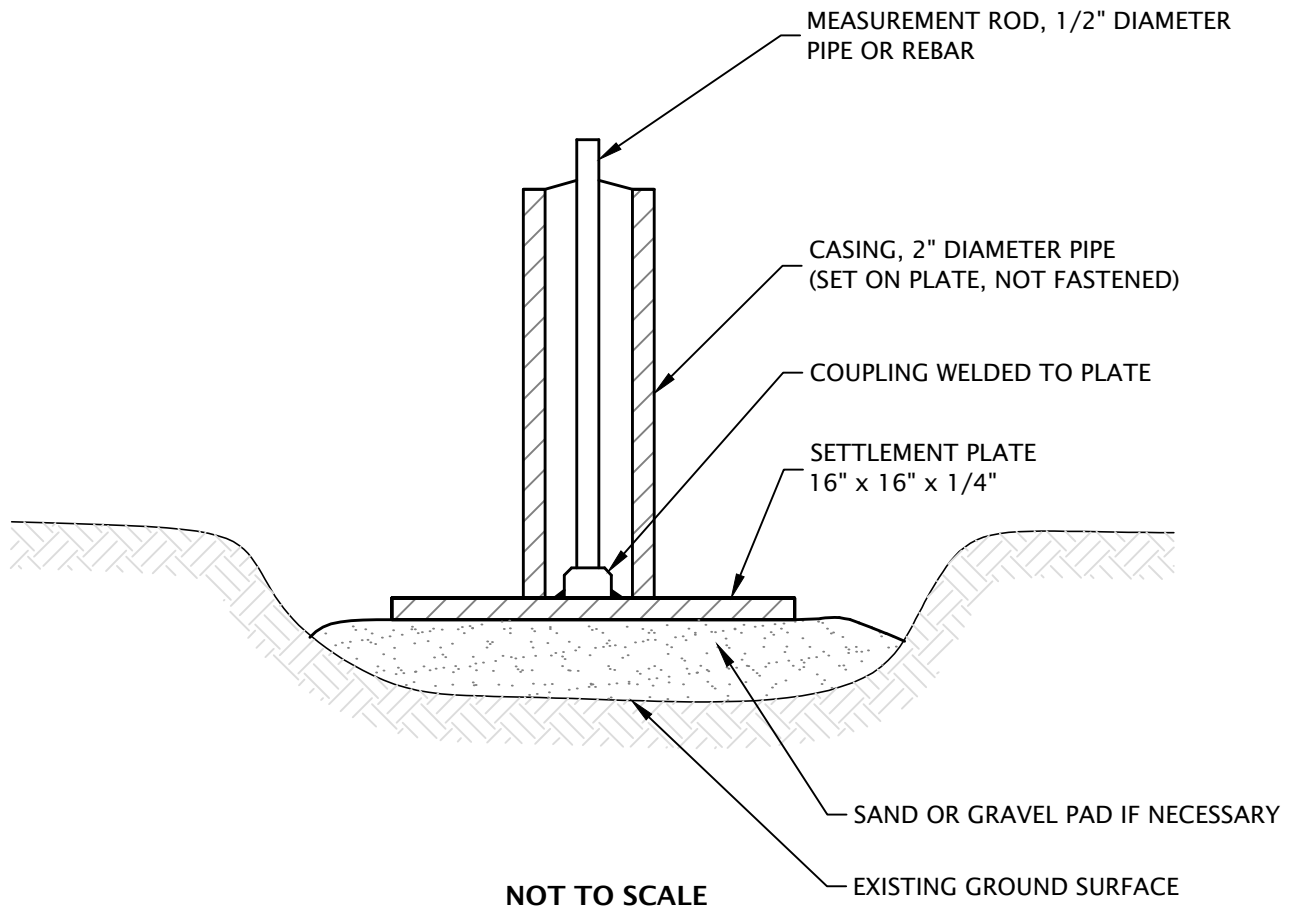


- LEGEND:
- B-1  BORING
  - TP-1  TEST PIT
  - CPT-1  CONE PENETROMETER



SITE PLAN BASED ON DRAWING PROVIDED BY  
DLR ON DECEMBER 2, 2015

 15575 SW Sequoia Parkway - Suite 100 Portland OR 97224 Off 503.968.8787 Fax 503.968.3068	BEAVSCHOOL-49-01	SITE PLAN	
	DECEMBER 2015	KAISER K5 WASHINGTON COUNTY, OR	
		FIGURE 2	



#### NOTES:

1. INSTALL MARKERS ON FIRM GROUND OR ON SAND OR GRAVEL PADS IF NEEDED FOR STABILITY. TAKE INITIAL READING ON TOP OF ROD AND AT ADJACENT GROUND LEVEL PRIOR TO PLACING ANY FILL.
2. FOR EASE IN HANDLING, ROD AND CASING ARE USUALLY INSTALLED IN 5-FOOT SECTIONS. AS FILL PROGRESSES, COUPLINGS ARE USED TO INSTALL ADDITIONAL LENGTHS. CONTINUITY IS MAINTAINED BY READING THE TOP OF THE MEASUREMENT ROD, THEN IMMEDIATELY ADDING THE NEW SECTION AND READING THE TOP OF THE ADDED ROD. BOTH READINGS ARE RECORDED.
3. RECORD THE ELEVATION OF THE TOP OF THE MEASUREMENT ROD IN EACH MARKER AT THE RECOMMENDED TIME INTERVALS. EACH TIME, NOTE THE ELEVATION OF THE ADJACENT FILL SURFACE.
4. READ THE MARKER TO THE NEAREST 0.01 FOOT, OR 0.005 FOOT IF POSSIBLE. NOTE THE FILL ELEVATION TO THE NEAREST 0.1 FOOT.
5. THE ELEVATIONS SHOULD BE REFERENCED TO A TEMPORARY BENCHMARK LOCATED ON STABLE GROUND AT LEAST 500 FEET FROM THE EMBANKMENT.

## APPENDIX A

## **APPENDIX A**

### **FIELD EXPLORATIONS**

#### ***GENERAL***

We explored the site by drilling four borings (B-1 through B-4), excavating eight test pits (TP-1 through TP-8), and performing one CPT probe (CPT-1). The borings were completed to depths ranging from 31.5 to 73.0 feet BGS on September 14 and 15, 2015 using mud rotary drilling methods by Western States Soil Conservation, Inc. of Hubbard, Oregon. The test pits were completed to a depth of 6.0 feet BGS on September 14, 2015 with a trackhoe operated by Dan J. Fischer Excavating, Inc. of Forest Grove, Oregon. The CPT probe was completed to a depth of approximately 54 feet BGS on September 16, 2015 by Oregon Geotechnical Explorations.

The explorations were observed by a member of our geology/engineering staff. We obtained representative samples of the various soil encountered in the explorations for geotechnical laboratory testing. Classifications and sampling depths are shown on the exploration logs presented in this appendix.

Approximate locations of our explorations are shown on Figure 2. Exploration locations were chosen based on preliminary site plans provided to our office by BSD. The locations of the explorations were determined in the field by pacing from existing site features. Longitudes/latitudes were determined by overlaying these locations on Google Earth. Our estimates of the longitudes/latitudes are shown on the exploration logs. This information should be considered accurate only to the degree implied by the methods used.

#### ***SOIL SAMPLING***

We obtained representative samples of the various soil encountered in the explorations for geotechnical laboratory testing. Soil samples were obtained from the borings using SPT sampling methods. SPTs were performed in general conformance with ASTM D 1586. The sampler was driven with a 140-pound hammer free-falling 30 inches. The number of blows required to drive the sampler 1 foot, or as otherwise indicated, into the soil is shown adjacent to the sample symbols on the exploration logs. Disturbed samples were obtained from the split barrel for subsequent classification and index testing. In addition, relatively undisturbed samples were obtained by pushing thin-walled standard Shelby tubes into the base of the boring in general accordance with ASTM D 1587.

Grab samples were obtained during the explorations from the test pit walls and/or base using the excavator bucket.

#### ***SOIL CLASSIFICATION***

The soil samples were classified in accordance with the "Exploration Key" (Table A-1) and "Soil Classification System" (Table A-2), which are presented in this appendix. The exploration logs indicate the depths at which the soils or their characteristics change, although the change could be gradual. If the change occurred between sample locations, the depth was interpreted. Classifications and sampling intervals are shown on the exploration logs presented in this appendix.

The average efficiency of the automatic SPT hammer used by Western States Soil Conservation, Inc. was 94.0 percent. A copy of the calibration testing is presented at the end of this appendix.

## **LABORATORY TESTING**

### ***CLASSIFICATION***

The soil samples were classified in the laboratory to confirm field classifications. The laboratory classifications are shown on the exploration logs if those classifications differed from the field classifications.

### ***MOISTURE CONTENT***










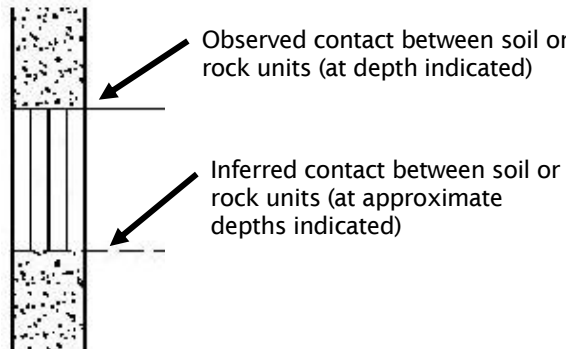

We tested the natural moisture content of selected samples obtained from the explorations in general accordance with ASTM D 2216. The natural moisture content is a ratio of the weight of the water to soil in a test sample and is expressed as a percentage. The test results are presented in this appendix.

### ***ATTERBERG LIMITS TESTING***

Atterberg limits (plastic and liquid limits) testing was performed on selected samples in general accordance with ASTM D 4318. The plastic limit is defined as the moisture content where the soil becomes brittle. The liquid limit is defined as the moisture content where the soil begins to act similar to a liquid. The plasticity index is the difference between the liquid and plastic limits. The test results are presented in this appendix.

### ***CONSOLIDATION TESTING***

A one-dimensional consolidation test was completed on one relatively undisturbed soil sample obtained from the explorations. The test was conducted in general accordance with ASTM D 2435. The test measures the volume change (consolidation) of a soil sample under predetermined loads. The test results are presented in this appendix.

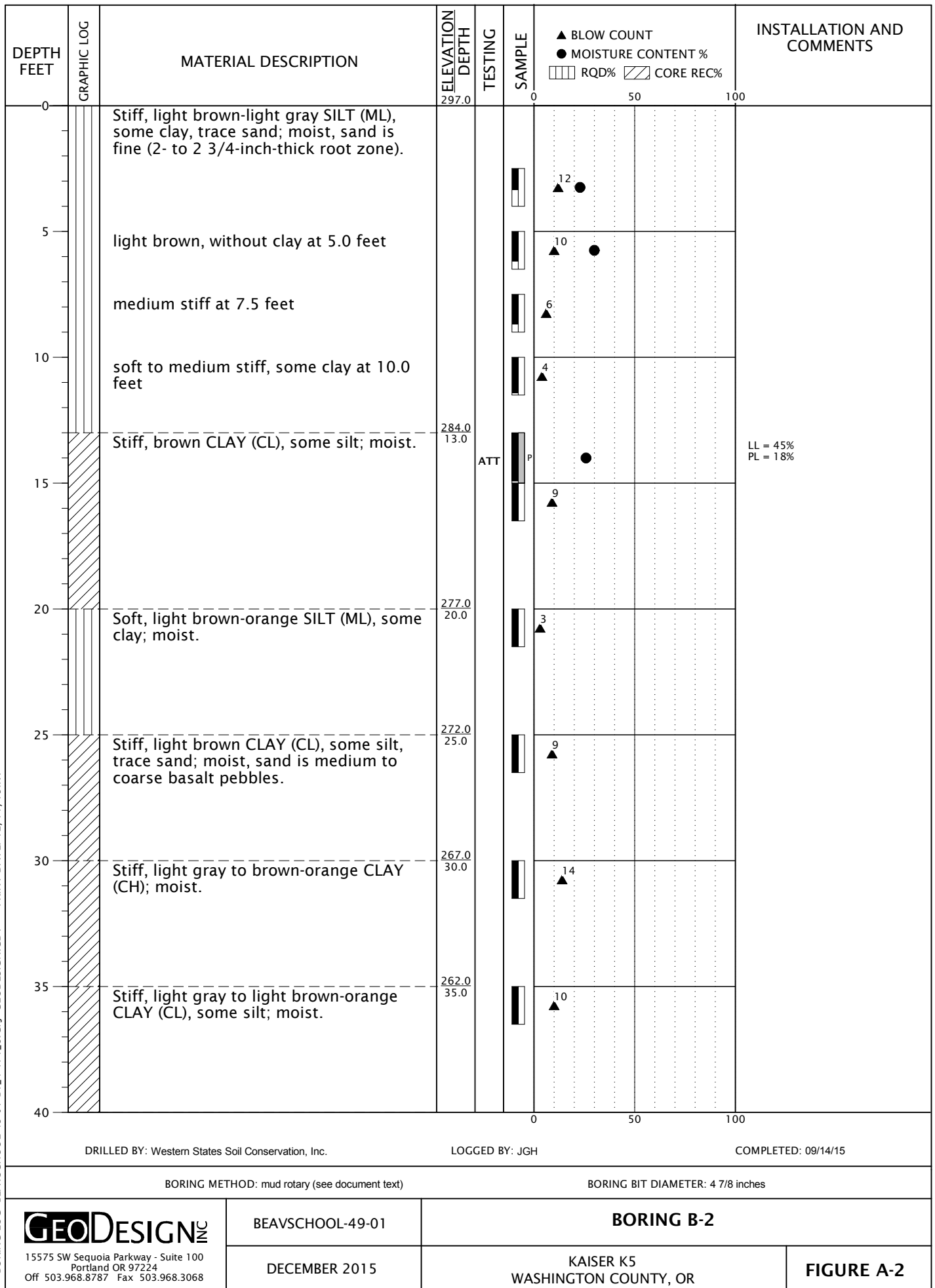
SYMBOL		SAMPLING DESCRIPTION	
		Location of sample obtained in general accordance with ASTM D 1586 Standard Penetration Test with recovery	
		Location of sample obtained using thin-wall Shelby tube or Geoprobe® sampler in general accordance with ASTM D 1587 with recovery	
		Location of sample obtained using Dames & Moore sampler and 300-pound hammer or pushed with recovery	
		Location of sample obtained using Dames & Moore and 140-pound hammer or pushed with recovery	
		Location of sample obtained using 3-inch-O.D. California split-spoon sampler and 140-pound hammer	
		Location of grab sample	
		Rock coring interval	
		Water level during drilling	
		Water level taken on date shown	
<div><div>Graphic Log of Soil and Rock Types</div></div>			
GEOTECHNICAL TESTING EXPLANATIONS			
ATT	Atterberg Limits	PP	Pocket Penetrometer
CBR	California Bearing Ratio	P200	Percent Passing U.S. Standard No. 200 Sieve
CON	Consolidation		
DD	Dry Density	RES	Resilient Modulus
DS	Direct Shear	SIEV	Sieve Gradation
HYD	Hydrometer Gradation	TOR	Torvane
MC	Moisture Content	UC	Unconfined Compressive Strength
MD	Moisture-Density Relationship	VS	Vane Shear
OC	Organic Content	kPa	Kilopascal
P	Pushed Sample		
ENVIRONMENTAL TESTING EXPLANATIONS			
CA	Sample Submitted for Chemical Analysis	ND	Not Detected
P	Pushed Sample	NS	No Visible Sheen
PID	Photoionization Detector Headspace Analysis	SS	Slight Sheen
		MS	Moderate Sheen
ppm	Parts per Million	HS	Heavy Sheen
 15575 SW Sequoia Parkway - Suite 100 Portland OR 97224 Off 503.968.8787 Fax 503.968.3068		EXPLORATION KEY	
			TABLE A-1

RELATIVE DENSITY - COARSE-GRAINED SOILS									
Relative Density		Standard Penetration Resistance		Dames & Moore Sampler (140-pound hammer)		Dames & Moore Sampler (300-pound hammer)			
Very Loose		0 - 4		0 - 11		0 - 4			
Loose		4 - 10		11 - 26		4 - 10			
Medium Dense		10 - 30		26 - 74		10 - 30			
Dense		30 - 50		74 - 120		30 - 47			
Very Dense		More than 50		More than 120		More than 47			
CONSISTENCY - FINE-GRAINED SOILS									
Consistency		Standard Penetration Resistance		Dames & Moore Sampler (140-pound hammer)		Dames & Moore Sampler (300-pound hammer)		Unconfined Compressive Strength (tsf)	
Very Soft		Less than 2		Less than 3		Less than 2		Less than 0.25	
Soft		2 - 4		3 - 6		2 - 5		0.25 - 0.50	
Medium Stiff		4 - 8		6 - 12		5 - 9		0.50 - 1.0	
Stiff		8 - 15		12 - 25		9 - 19		1.0 - 2.0	
Very Stiff		15 - 30		25 - 65		19 - 31		2.0 - 4.0	
Hard		More than 30		More than 65		More than 31		More than 4.0	
PRIMARY SOIL DIVISIONS				GROUP SYMBOL		GROUP NAME			
COARSE-GRAINED SOILS  (more than 50% retained on No. 200 sieve)		GRAVEL  (more than 50% of coarse fraction retained on No. 4 sieve)		CLEAN GRAVELS (< 5% fines)		GW or GP		GRAVEL	
				GRAVEL WITH FINES (≥ 5% and ≤ 12% fines)		GW-GM or GP-GM		GRAVEL with silt	
						GW-GC or GP-GC		GRAVEL with clay	
				GRAVELS WITH FINES (> 12% fines)		GM		silty GRAVEL	
						GC		clayey GRAVEL	
						GC-GM		silty, clayey GRAVEL	
		SAND  (50% or more of coarse fraction passing No. 4 sieve)		CLEAN SANDS (<5% fines)		SW or SP		SAND	
				SANDS WITH FINES (≥ 5% and ≤ 12% fines)		SW-SM or SP-SM		SAND with silt	
						SW-SC or SP-SC		SAND with clay	
				SANDS WITH FINES (> 12% fines)		SM		silty SAND	
						SC		clayey SAND	
						SC-SM		silty, clayey SAND	
FINE-GRAINED SOILS  (50% or more passing No. 200 sieve)		Liquid limit less than 50		ML		SILT			
				CL		CLAY			
				CL-ML		silty CLAY			
				OL		ORGANIC SILT or ORGANIC CLAY			
		Liquid limit 50 or greater		MH		SILT			
				CH		CLAY			
				OH		ORGANIC SILT or ORGANIC CLAY			
HIGHLY ORGANIC SOILS				PT		PEAT			
MOISTURE CLASSIFICATION			ADDITIONAL CONSTITUENTS						
Term	Field Test		Secondary granular components or other materials such as organics, man-made debris, etc.						
			Percent	Silt and Clay In:		Percent	Sand and Gravel In:		
Fine-Grained Soils	Coarse-Grained Soils	Fine-Grained Soils		Coarse-Grained Soils					
			dry		very low moisture, dry to touch				
moist	damp, without visible moisture	< 5	trace	trace	< 5	trace	trace		
		5 - 12	minor	with	5 - 15	minor	minor		
wet	visible free water, usually saturated	> 12	some	silty/clayey	15 - 30	with	with		
					> 30	sandy/gravelly	Indicate %		
<div><div><div><div><div><div><span></span></div><div><b>GEO</b></div></div><div><div><div><span></span></div><div><b>DESIGN</b></div></div><div><div><span></span></div><div><b>LLC</b></div></div></div><div><div><div><span></span></div><div><b>LLC</b></div></div></div></div><div><div><div><span></span></div><div><b>LLC</b></div></div></div></div><div><div><div><span></span></div><div><b>LLC</b></div></div></div></div><div><div><div><span></span></div><div><b>LLC</b></div></div></div></div> <div><div><div><span></span></div><div><b>LLC</b></div></div></div> <div><div><div><span></span></div><div><b>LLC</b></div></div></div> <div><div><div><span></span></div><div><b>LLC</b></div></div></div> <div><div><div><span></span></div><div><b>LLC</b></div></div></div> <div><div><div><span></span></div><div><b>LLC</b></div></div></div> <div><div><div><span></span></div><div><b>LLC</b></div></div></div> <div><div><div><span></span></div><div><b>LLC</b></div></div></div> 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BORING LOG BEAVSCHOOL-49-01-B1\_4-TP1\_8.GPJ GEODESIGN.CDT PRINT DATE: 12/11/15:KT

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	▲ BLOW COUNT ● MOISTURE CONTENT % RQD% CORE REC%	INSTALLATION AND COMMENTS
0		Medium dense GRAVEL (GP); moist - FILL.	308.0				
1.0		Stiff, light brown to light gray SILT (ML), some clay, trace sand; moist, sand is fine.	307.0				Gravel with PVC, wire, bark in cuttings.
5		stiff to very stiff, light brown-orange, minor sand, without clay at 5.0 feet					
7.5		medium stiff, light brown, trace sand at 7.5 feet					
10		brown, trace clay at 10.0 feet					
15		very soft, light brown, some clay at 15.0 feet					Bigger clumps in cuttings, more clay.
20		stiff at 20.0 feet					Moisture up, but no visible water.
25							
30							
31.5		Exploration completed at a depth of 31.5 feet.	276.5				
31.5		Hammer efficiency factor is 94.2 percent. Latitude: 45.575893 Longitude: -122.837731 (determined from Google Earth)	31.5				
35							
40							
DRILLED BY: Western States Soil Conservation, Inc.           LOGGED BY: JGH           COMPLETED: 09/14/15							
BORING METHOD: mud rotary (see document text)           BORING BIT DIAMETER: 4 7/8 inches							
<b>GEODESIGN</b> 15575 SW Sequoia Parkway - Suite 100 Portland OR 97224 Off 503.968.8787 Fax 503.968.3068		BEAVSCHOOL-49-01	BORING B-1				
		DECEMBER 2015	KAISER K5 WASHINGTON COUNTY, OR				FIGURE A-1

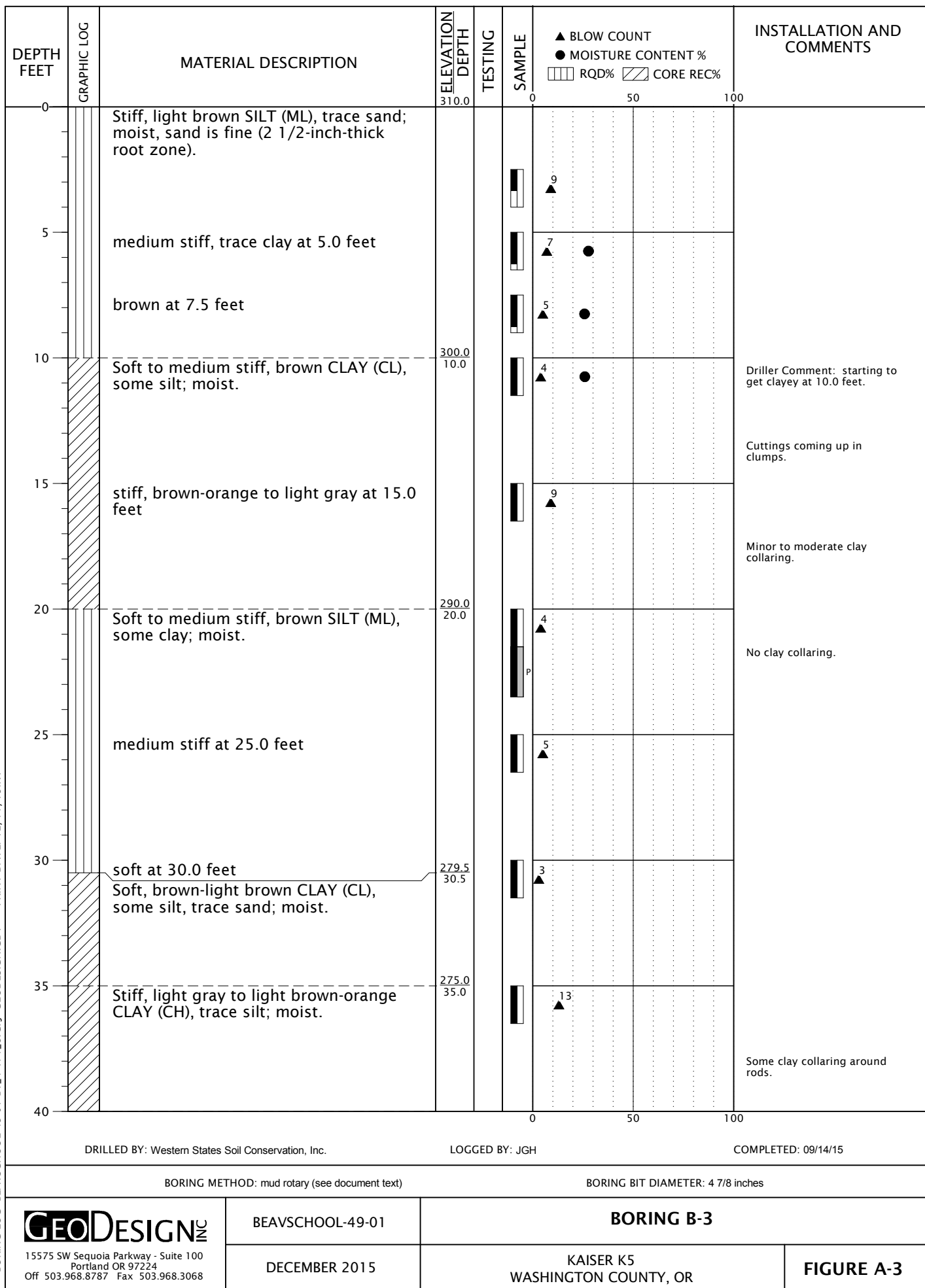
BORING LOG BEAVSCHOOL-49-01-B1\_4-TP1\_8.GPJ GEODESIGN.GDT PRINT DATE: 12/11/15:KT



BORING LOG BEAVSCHOOL-49-01-B1\_4-TP1\_8.GPJ GEODESIGN.CDT PRINT DATE: 12/11/15:KT

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	▲ BLOW COUNT ● MOISTURE CONTENT % RQD% CORE REC%	INSTALLATION AND COMMENTS
40		Very stiff, light gray with dark gray speckled CLAY (CH), trace sand; moist, sand is dark gray basalt speckles.  Exploration completed at a depth of 41.5 feet.  Hammer efficiency factor is 94.2 percent. Latitude: 45.574942 Longitude: -122.838209 (determined from Google Earth)	257.0 40.0 255.5 41.5		0	18 50 100	
45							
50							
55							
60							
65							
70							
75							
80							
DRILLED BY: Western States Soil Conservation, Inc.           LOGGED BY: JGH           COMPLETED: 09/14/15							
BORING METHOD: mud rotary (see document text)           BORING BIT DIAMETER: 4 7/8 inches							
<b>GEODESIGN</b> 15575 SW Sequoia Parkway - Suite 100 Portland OR 97224 Off 503.968.8787 Fax 503.968.3068		BEAVSCHOOL-49-01	<b>BORING B-2</b> (continued)				
		DECEMBER 2015	KAISER K5 WASHINGTON COUNTY, OR				FIGURE A-2

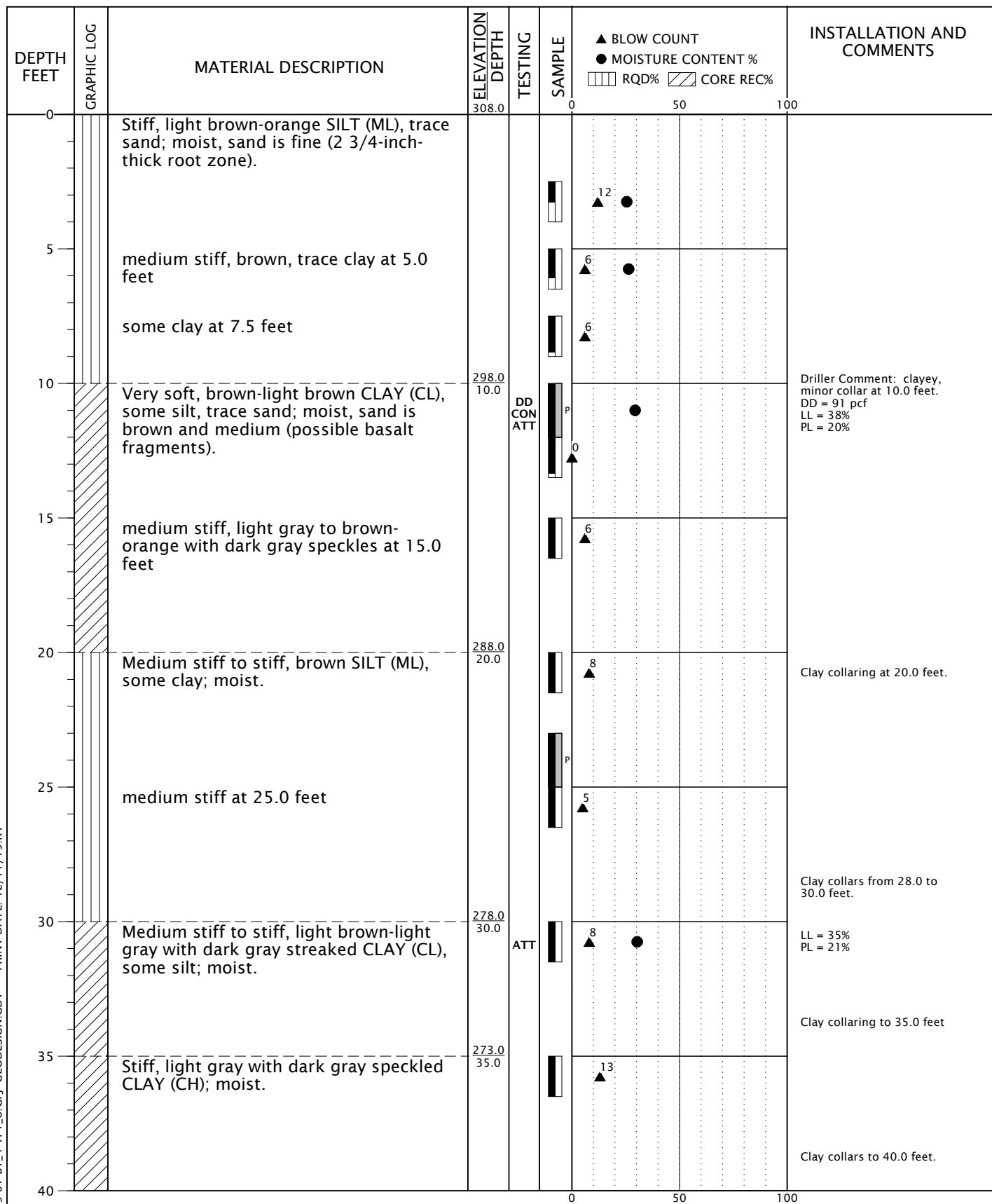
BORING LOG BEAVSCHOOL-49-01-B1\_4-TP1\_8.GPJ GEODESIGN.GDT PRINT DATE: 12/11/15:KT



BORING LOG BEAVSCHOOL-49-01-B1\_4-TP1\_8.GPJ GEODESIGN.GDT PRINT DATE: 12/11/15:KT

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	▲ BLOW COUNT ● MOISTURE CONTENT % RQD% CORE REC%	INSTALLATION AND COMMENTS
40		Stiff, brown to light gray SILT (ML), some clay; moist.	270.0 40.0				
		Exploration completed at a depth of 41.5 feet.	268.5 41.5				
45		Hammer efficiency factor is 94.2 percent. Latitude: 45.575508 Longitude: -122.837401 (determined from Google Earth)					
50							
55							
60							
65							
70							
75							
80							
DRILLED BY: Western States Soil Conservation, Inc.           LOGGED BY: JGH           COMPLETED: 09/14/15							
BORING METHOD: mud rotary (see document text)           BORING BIT DIAMETER: 4 7/8 inches							
<b>GEODESIGN</b> 15575 SW Sequoia Parkway - Suite 100 Portland OR 97224 Off 503.968.8787 Fax 503.968.3068		BEAVSCHOOL-49-01	<b>BORING B-3</b> (continued)				
		DECEMBER 2015	KAISER K5 WASHINGTON COUNTY, OR				FIGURE A-3

BORING LOG BEAVSCHOOL-49-01-B1\_4-TP1\_8.GPJ GEODESIGN.GDT PRINT DATE: 12/11/15:KT



DRILLED BY: Western States Soil Conservation, Inc.

LOGGED BY: JGH

COMPLETED: 09/15/15

BORING METHOD: mud rotary (see document text)

BORING BIT DIAMETER: 4 7/8 inches



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Off 503.968.8787 Fax 503.968.3068

BEAVSCHOOL-49-01

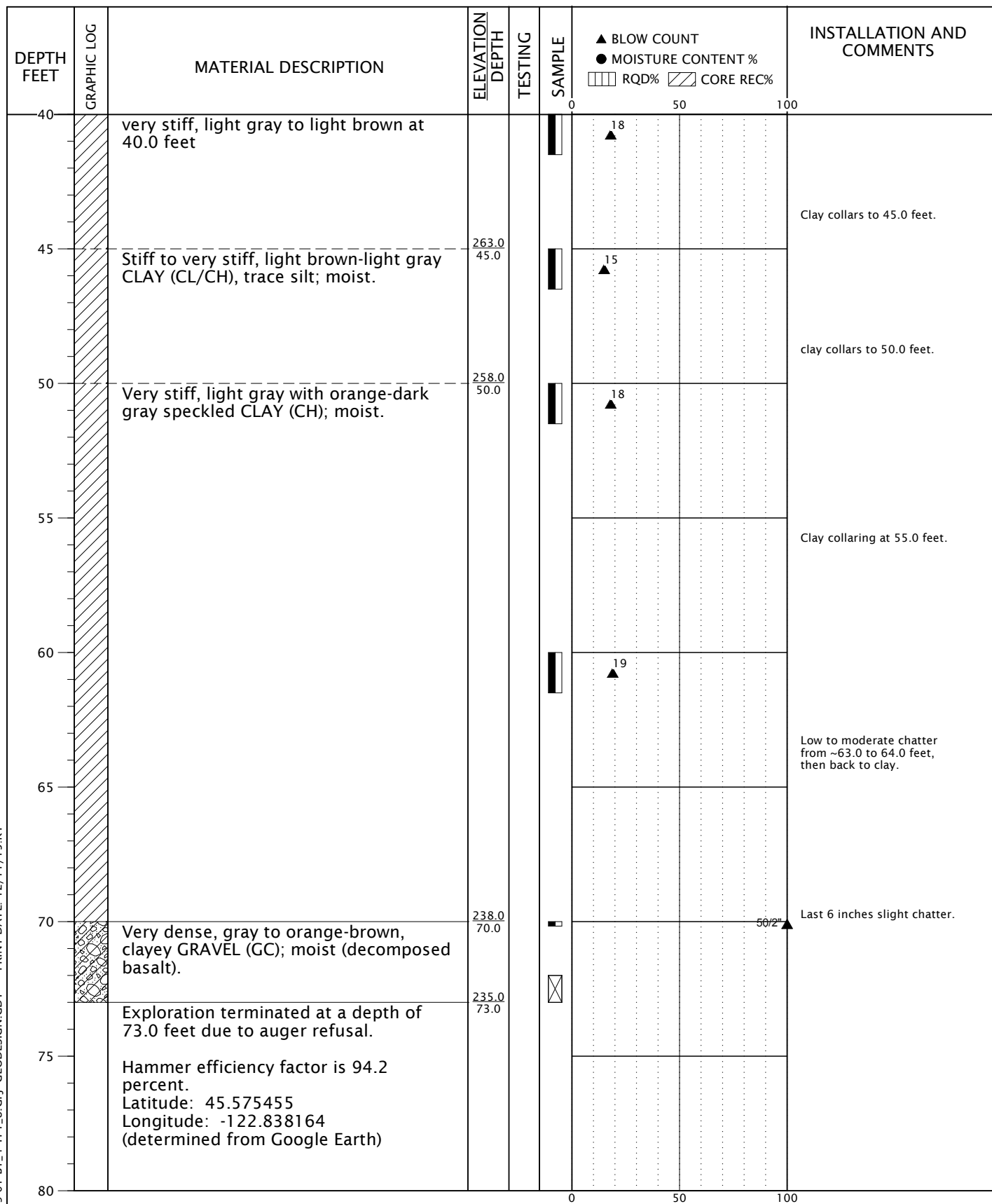
DECEMBER 2015

**BORING B-4**

KAISER K5  
WASHINGTON COUNTY, OR

**FIGURE A-4**

BORING LOG BEAVSCHOOL-49-01-B1\_4-TP1\_8.GPJ GEODESIGN.CDT PRINT DATE: 12/11/15:KT



DRILLED BY: Western States Soil Conservation, Inc.

LOGGED BY: JGH

COMPLETED: 09/15/15

BORING METHOD: mud rotary (see document text)

BORING BIT DIAMETER: 4 7/8 inches



15575 SW Sequoia Parkway - Suite 100  
 Portland OR 97224  
 Off 503.968.8787 Fax 503.968.3068


BEAVSCHOOL-49-01

DECEMBER 2015


**BORING B-4**  
(continued)

KAISER K5  
 WASHINGTON COUNTY, OR

**FIGURE A-4**

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT (%)	COMMENTS
<b>TP-1</b>							
0.0		Stiff, brown SILT (ML), trace sand; moist, sand is fine (8-inch-thick tilled zone, 2-inch-thick root zone).	309.0			0 50 100	
2.5				PP	☒	●	PP = > tsf
5.0		brown with gray mottles at 4.5 feet					
		Exploration completed at a depth of 6.0 feet.	303.0 6.0	PP	☒		PP = 1.5 tsf
7.5		Latitude: 45.57596 Longitude: -122.83905 (determined from Google Earth)					No groundwater seepage observed to the depth explored. No caving observed to the depth explored.
10.0							
12.5							
<b>TP-2</b>							
0.0		Stiff, brown SILT (ML), trace sand; moist, sand is fine (8- to 12-inch-thick tilled zone, 3-inch-thick root zone).	311.0			0 50 100	
2.5				PP	☒	●	PP = >3.0 tsf
5.0				PP	☒	●	PP = 1.5 tsf
		Exploration completed at a depth of 6.0 feet.	305.0 6.0				No groundwater seepage observed to the depth explored. No caving observed to the depth explored.
7.5		Latitude: 45.57524 Longitude: -122.83698 (determined from Google Earth)					
10.0							
12.5							
<div>EXCAVATED BY: Dan J. Fischer Excavating, Inc.</div> <div>LOGGED BY: CR</div> <div>COMPLETED: 09/14/15</div>							
EXCAVATION METHOD: trackhoe (see document text)							
 15575 SW Sequoia Parkway - Suite 100 Portland OR 97224 Off 503.968.8787 Fax 503.968.3068		BEAVSCHOOL-49-01	TEST PIT				
		DECEMBER 2015	KAISER K5 WASHINGTON COUNTY, OR				FIGURE A-5


TEST PIT LOG - 2 PER PAGE BEAVSCHOOL-49-01-B1\_4-TP1\_8.GPJ GEODESIGN.GDT PRINT DATE: 12/11/15:KT

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT (%)	COMMENTS
<b>TP-3</b>							
0.0		Stiff, brown SILT (ML), trace sand; moist, sand is fine (8-inch-thick tilled zone, 3-inch-thick root zone).	291.0			0 50 100	
2.5				PP	☒		PP = >3.0 tsf
5.0							
6.0		Exploration completed at a depth of 6.0 feet.	285.0 6.0				No groundwater seepage observed to the depth explored. No caving observed to the depth explored.
7.5		Latitude: 45.57524 Longitude: -122.83698 (determined from Google Earth)					
10.0							
12.5							
<b>TP-4</b>							
0.0		Stiff, brown SILT (ML), trace sand; moist, sand is fine (8-inch-thick tilled zone, 3-inch-thick root zone).	279.0			0 50 100	
2.5				PP	☒		PP = >3.0 tsf
3.5		brown with gray mottles at 3.5 feet					
5.0				PP	☒		PP = >2.0 tsf
6.0		Exploration completed at a depth of 6.0 feet.	273.0 6.0				PP = 2.0 tsf
7.5		Latitude: 45.57511 Longitude: -122.83936 (determined from Google Earth)					No groundwater seepage observed to the depth explored. No caving observed to the depth explored.
10.0							
12.5							
<div>EXCAVATED BY: Dan J. Fischer Excavating, Inc.</div> <div>LOGGED BY: CR</div> <div>COMPLETED: 09/14/15</div>							
EXCAVATION METHOD: trackhoe (see document text)							
		BEAVSCHOOL-49-01		TEST PIT			
15575 SW Sequoia Parkway - Suite 100 Portland OR 97224 Off 503.968.8787 Fax 503.968.3068		DECEMBER 2015		KAISER K5 WASHINGTON COUNTY, OR		FIGURE A-6	

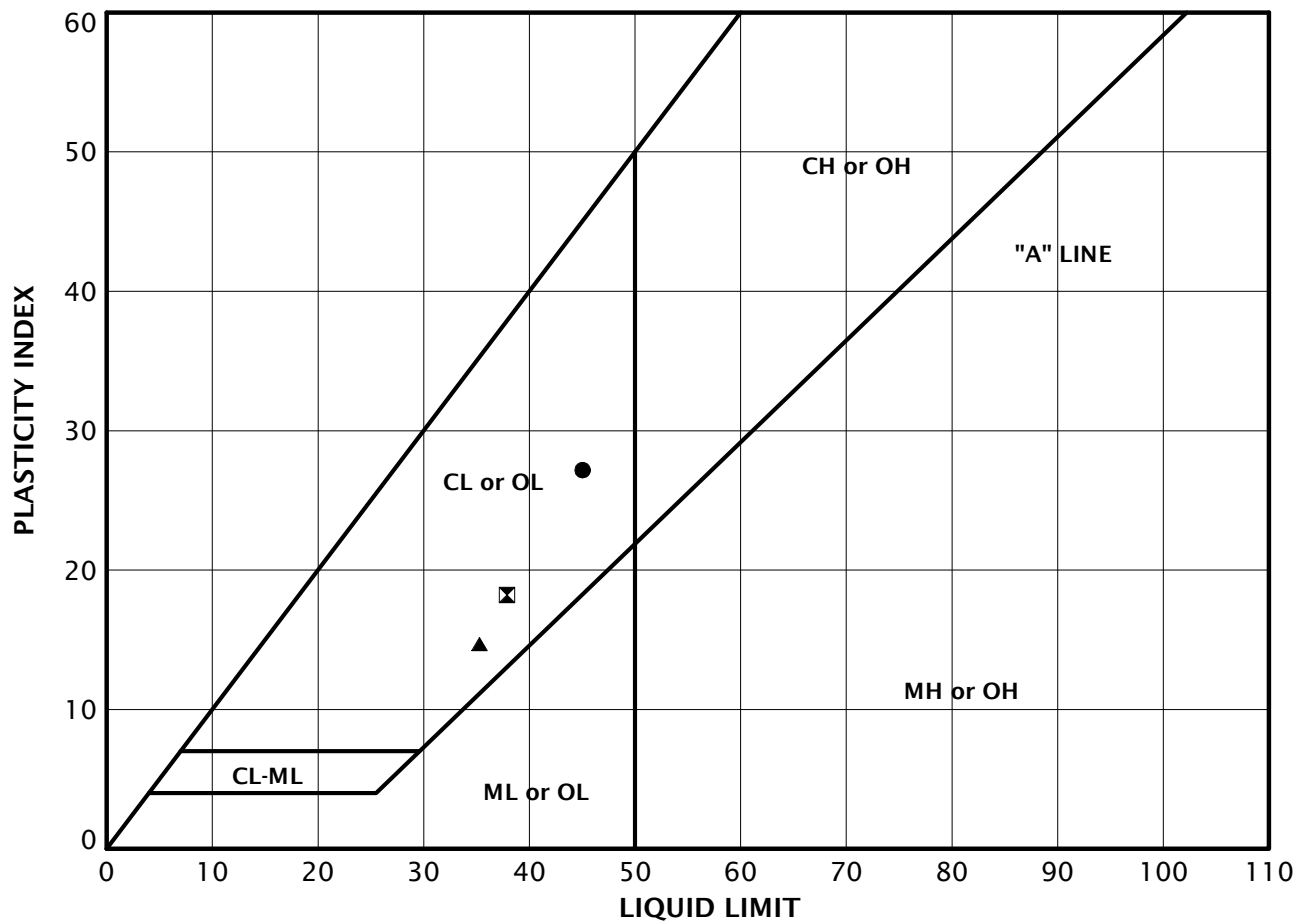
TEST PIT LOG - 2 PER PAGE BEAVSCHOOL-49-01-B1\_4-TP1\_8.GPJ GEODESIGN.GDT PRINT DATE: 12/11/15:KT

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT (%)	COMMENTS
TP-5							
0.0		Stiff, brown SILT (ML), trace sand; moist, sand is fine (10-inch-thick tilled zone, 3-inch-thick root zone).	303.0			0 50 100	
2.5				PP	☒	●	PP = >3.0 tsf
5.0		brown with gray mottles at 5.0 feet	297.0		☒	●	PP = 2.0 tsf
6.0		Exploration completed at a depth of 6.0 feet.	6.0				No groundwater seepage observed to the depth explored. No caving observed to the depth explored.
7.5		Latitude: 45.57505 Longitude: -122.83855 (determined from Google Earth)					
10.0							
12.5							
TP-6							
0.0		Stiff, brown SILT (ML), trace sand; moist, sand is fine (10-inch-thick tilled zone, 2-inch-thick root zone).	291.0			0 50 100	
2.5				PP	☒	●	PP = >3.0 tsf
5.0							
6.0		Exploration completed at a depth of 6.0 feet.	285.0		☒	●	No groundwater seepage observed to the depth explored. No caving observed to the depth explored.
7.5		Latitude: 45.57547 Longitude: -122.83972 (determined from Google Earth)					
10.0							
12.5							
EXCAVATED BY: Dan J. Fischer Excavating, Inc. LOGGED BY: CR COMPLETED: 09/14/15							
EXCAVATION METHOD: trackhoe (see document text)							
GEO DESIGN INC		BEAVSCHOOL-49-01	TEST PIT				
15575 SW Sequoia Parkway - Suite 100 Portland OR 97224 Off 503.968.8787 Fax 503.968.3068		DECEMBER 2015	KAISER K5 WASHINGTON COUNTY, OR			FIGURE A-7	

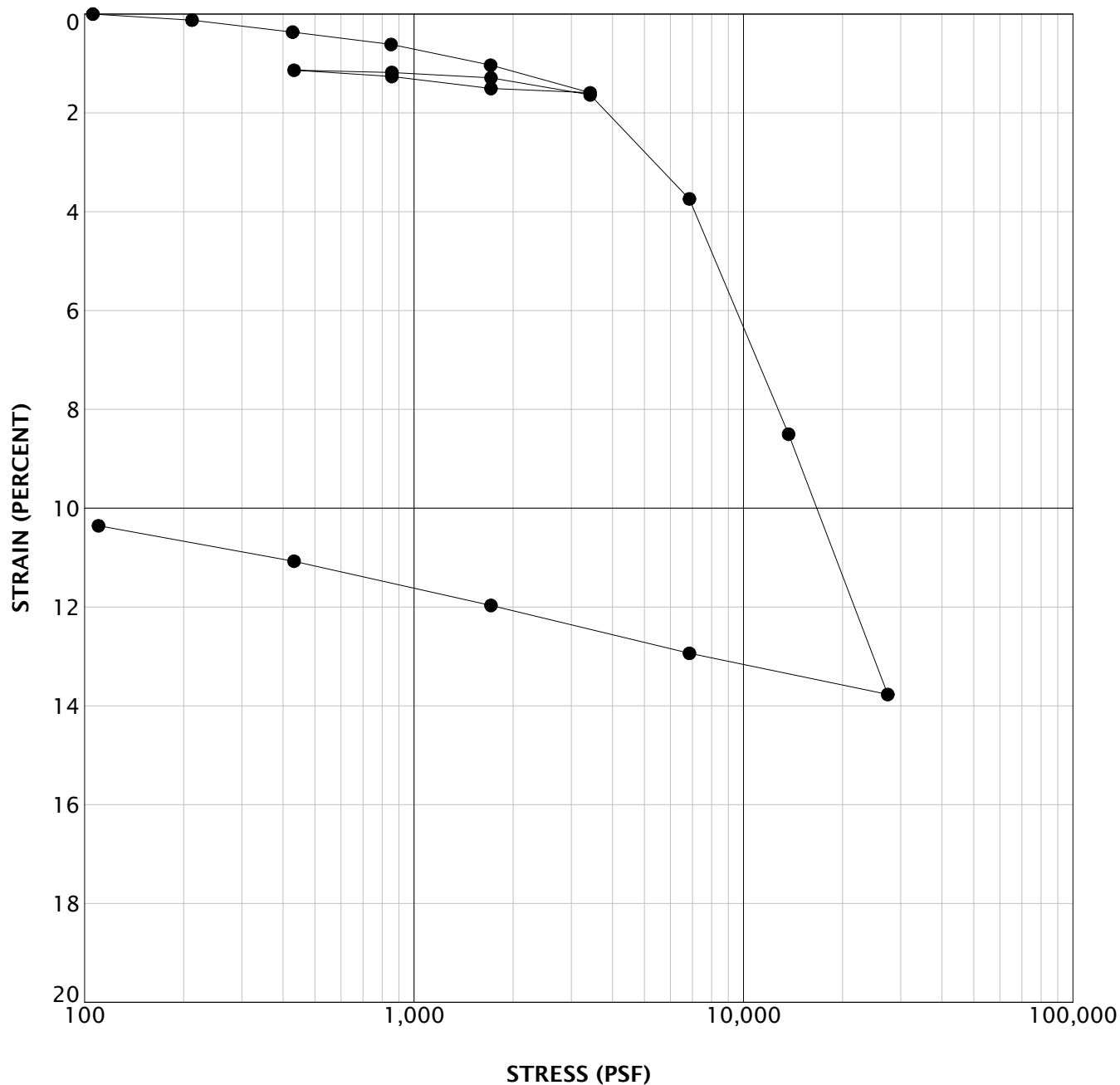
TEST PIT LOG - 2 PER PAGE BEAVSCHOOL-49-01-B1\_4-TP1\_8.GPJ GEODESIGN.GDT PRINT DATE: 12/11/15:KT

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT (%)	COMMENTS
<b>TP-7</b>							
0.0		Stiff, brown SILT (ML), trace sand; moist, sand is fine (10-inch-thick tilled zone, 3-inch-thick root zone).	297.0			0 50 100	
2.5				PP	☒	●	PP = >3.0 tsf
5.0							
6.0		Exploration completed at a depth of 6.0 feet.	291.0 6.0	PP	☒		PP = 1.5 tsf
7.5		Latitude: 45.57547 Longitude: -122.83972 (determined from Google Earth)					No groundwater seepage observed to the depth explored. No caving observed to the depth explored.
10.0							
12.5							
<b>TP-8</b>							
0.0		Stiff, brown SILT (ML), trace sand; moist, sand is fine (0- to 8inch-thick tilled zone, 2-inch-thick root zone).	307.0			0 50 100	
2.5				PP	☒	●	PP = 2.0 tsf
5.0							
6.0		Exploration completed at a depth of 6.0 feet.	301.0 6.0	PP	☒		PP = 1.5 tsf
7.5		Latitude: 45.57592 Longitude: -122.83825 (determined from Google Earth)					No groundwater seepage observed to the depth explored. No caving observed to the depth explored.
10.0							
12.5							
<div>EXCAVATED BY: Dan J. Fischer Excavating, Inc.</div> <div>LOGGED BY: CR</div> <div>COMPLETED: 09/14/15</div>							
EXCAVATION METHOD: trackhoe (see document text)							
		BEAVSCHOOL-49-01		TEST PIT			
15575 SW Sequoia Parkway - Suite 100 Portland OR 97224 Off 503.968.8787 Fax 503.968.3068		DECEMBER 2015		KAISER K5 WASHINGTON COUNTY, OR		FIGURE A-8	


TEST PIT LOG - 2 PER PAGE BEAVSCHOOL-49-01-B1\_4-TP1\_8.GPJ GEODESIGN.GDT PRINT DATE: 12/11/15:KT



KEY	EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	MOISTURE CONTENT (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
●	B-2	13.0	26	45	18	27
⊠	B-4	10.0	24	38	20	18
▲	B-4	30.0	30	35	21	14



KEY	EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)
●	B-4	10.0	29	91

SAMPLE INFORMATION			MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SIEVE			ATTERBERG LIMITS		
EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	ELEVATION (FEET)			GRAVEL (PERCENT)	SAND (PERCENT)	P200 (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
B-1	2.5	305.5	27							
B-1	5.0	303.0	27							
B-1	7.5	300.5	27							
B-1	10.0	298.0	28							
B-2	2.5	294.5	23							
B-2	5.0	292.0	30							
B-2	13.0	284.0	26					45	18	27
B-3	5.0	305.0	28							
B-3	7.5	302.5	26							
B-3	10.0	300.0	26							
B-4	2.5	305.5	25							
B-4	5.0	303.0	26							
B-4	10.0	298.0	29	91				38	20	18
B-4	30.0	278.0	30					35	21	14
TP-1	3.0	306.0	13							
TP-2	1.0	310.0	10							
TP-2	4.0	307.0	27							
TP-5	1.5	301.5	19							
TP-5	5.0	298.0	27							
TP-6	2.0	289.0	21							
TP-6	5.8	285.3	26							
TP-7	1.0	296.0	12							
TP-8	1.5	305.5	16							
 15575 SW Sequoia Parkway - Suite 100 Portland OR 97224 Off 503.968.8787 Fax 503.968.3068			BEAVSCHOOL-49-01		SUMMARY OF LABORATORY DATA					
			DECEMBER 2015		KAISER K5 WASHINGTON COUNTY, OR				FIGURE A-11	

WSSC-7-01 - TEST BORING B-6 25FT  
OP: WMN

TRUCK NO. 5  
Date: 30-May-2015

AR: 1.41 in<sup>2</sup>  
LE: 29.42 ft  
WS: 16,807.9 f/s

SP: 0.492 k/ft<sup>3</sup>  
EM: 30,000 ksi  
JC: 0.00

ETR: Energy Transfer Ratio  
EMX: Max Transferred Energy  
CSB: Compression Stress at Bottom  
BPM: Blows per Minute  
FFS: Force Full Scale

DMX: Maximum Displacement  
SFR: Skin friction w/ damping correction  
MEX: Maximum Strain  
VMX: Maximum Velocity

BL#	depth ft	BLC bl/ft	ETR (%)	EMX k-ft	CSB ksi	BPM bpm	FFS kips	DMX in	SFR kips	MEX μE	VMX f/s
10	25.00	6	87.8	0.3	0.0	42.9	60	1.16	0	1,087	17.7
11	25.18	6	92.2	0.3	0.0	43.1	60	1.86	0	1,119	18.6
12	25.36	6	95.3	0.3	0.0	43.1	60	0.87	0	1,116	18.4
13	25.54	6	94.2	0.3	0.0	43.1	60	1.08	0	1,183	18.6
14	25.71	6	88.3	0.3	0.0	43.3	60	0.66	0	1,113	17.4
15	25.89	6	90.2	0.3	0.0	43.1	60	1.41	0	1,064	17.6
16	26.07	6	95.2	0.3	0.0	43.2	60	1.38	0	1,105	18.3
17	26.25	6	86.0	0.3	0.0	43.2	60	0.90	0	1,060	17.0
18	26.43	6	88.7	0.3	0.0	43.2	60	1.02	0	1,139	17.3
19	26.61	6	89.6	0.3	0.0	43.2	60	1.53	0	1,125	18.0
20	26.79	6	93.7	0.3	0.0	43.1	60	1.02	0	1,150	18.0
21	26.96	6	91.3	0.3	0.0	43.2	60	1.44	0	1,098	17.4
22	27.14	6	93.2	0.3	0.0	43.1	60	0.91	0	1,123	17.9
23	27.32	6	90.9	0.3	0.0	43.2	60	0.98	0	1,111	17.3
24	27.50	6	94.6	0.3	0.0	43.1	60	0.85	0	1,201	18.0
25	27.68	6	95.9	0.3	0.0	43.1	60	0.89	0	1,197	18.1
26	27.86	6	92.4	0.3	0.0	43.2	60	1.63	0	1,066	17.0
27	28.04	6	85.8	0.3	0.0	43.2	60	0.52	0	1,116	16.0
28	28.21	6	90.5	0.3	0.0	43.2	60	0.62	0	1,120	16.6
29	28.39	6	89.1	0.3	0.0	43.2	60	0.97	0	1,133	16.4
30	28.57	6	89.5	0.3	0.0	43.4	60	0.62	0	1,146	16.2
31	28.75	6	90.7	0.3	0.0	43.0	60	0.80	0	1,092	16.3
38	30.00	6	92.2	0.3	0.0	48.0	60	0.92	0	1,004	18.2
39	30.17	6	90.3	0.3	0.0	47.8	60	1.17	0	1,025	18.2
40	30.33	6	94.2	0.3	0.0	47.9	60	0.90	0	1,008	18.2
41	30.50	6	96.5	0.3	0.0	47.5	60	1.02	0	1,027	18.3
42	30.67	6	92.7	0.3	0.0	47.9	60	1.27	0	1,000	18.1
43	30.83	6	91.8	0.3	0.0	47.9	60	1.00	0	1,018	18.4
44	31.00	6	94.9	0.3	0.0	47.8	60	1.42	0	1,023	18.1
45	31.17	6	95.2	0.3	0.0	47.7	60	1.20	0	1,072	18.4
46	31.33	6	97.9	0.3	0.0	47.8	60	1.57	0	998	18.0
47	31.50	6	93.0	0.3	0.0	47.8	60	0.90	0	1,008	18.0
48	31.67	6	91.1	0.3	0.0	47.7	60	0.92	0	981	17.7
49	31.83	6	94.3	0.3	0.0	48.1	60	1.01	0	1,013	18.2
50	32.00	6	95.1	0.3	0.0	47.8	60	0.92	0	1,073	18.5
51	32.17	6	90.9	0.3	0.0	47.8	60	0.72	0	1,003	17.7
52	32.33	6	93.5	0.3	0.0	47.7	60	0.91	0	1,005	17.8
53	32.50	6	97.8	0.3	0.0	48.0	60	0.96	0	1,065	18.4
54	32.67	6	100.2	0.4	0.0	47.8	60	1.31	0	1,017	18.2
55	32.83	6	91.6	0.3	0.0	47.6	60	0.64	0	1,054	18.1
56	33.00	6	84.5	0.3	0.0	48.0	60	0.80	0	983	17.3
57	33.17	6	88.4	0.3	0.0	47.9	60	0.40	0	1,050	18.1
58	33.33	6	99.6	0.3	0.0	47.6	60	1.72	0	1,012	17.9
68	35.00	6	96.0	0.3	0.0	46.9	60	0.85	0	1,023	17.8
69	35.12	8	89.8	0.3	0.0	47.0	60	0.70	0	972	17.1

WSSC-7-01 - TEST BORING B-6 25FT  
OP: WMN

TRUCK NO. 5  
Date: 30-May-2015

BL#	depth ft	BLC bl/ft	ETR (%)	EMX k-ft	CSB ksi	BPM bpm	FFS kips	DMX in	SFR kips	MEX μE	VMX f/s
70	35.24	8	96.5	0.3	0.0	46.9	60	0.75	0	1,089	18.4
71	35.37	8	73.6	0.3	0.0	46.5	60	0.96	0	906	15.5
72	35.49	8	99.6	0.3	0.0	47.4	60	0.67	0	1,028	18.3
73	35.61	8	93.9	0.3	0.0	47.0	60	0.68	0	1,018	17.5
74	35.73	8	93.0	0.3	0.0	47.0	60	0.71	0	1,007	17.6
75	35.85	8	93.1	0.3	0.0	46.9	60	0.94	0	1,014	17.3
76	35.98	8	97.3	0.3	0.0	46.9	60	1.05	0	1,013	17.7
77	36.10	8	92.0	0.3	0.0	47.1	60	0.56	0	1,024	17.3
78	36.22	8	95.5	0.3	0.0	46.9	60	0.82	0	1,015	17.6
79	36.34	8	96.7	0.3	0.0	47.0	60	1.26	0	1,037	17.9
80	36.46	8	97.5	0.3	0.0	47.0	60	0.66	0	1,051	18.2
81	36.59	8	99.7	0.3	0.0	47.1	60	0.57	0	1,071	18.4
82	36.71	8	93.1	0.3	0.0	47.0	60	0.75	0	1,041	17.6
83	36.83	8	101.8	0.4	0.0	46.9	60	1.14	0	1,043	18.4
84	36.95	8	93.0	0.3	0.0	47.0	60	0.54	0	1,033	17.6
85	37.07	8	101.3	0.4	0.0	46.9	60	1.11	0	1,076	18.4
86	37.20	8	96.0	0.3	0.0	47.0	60	0.75	0	1,030	18.1
87	37.32	8	94.5	0.3	0.0	47.1	60	0.38	0	1,069	18.0
88	37.44	8	100.3	0.4	0.0	46.9	60	1.11	0	1,079	18.4
89	37.56	8	103.0	0.4	0.0	47.0	60	1.24	0	1,065	18.4
90	37.68	8	92.4	0.3	0.0	46.9	60	0.61	0	1,022	17.7
91	37.80	8	97.4	0.3	0.0	47.0	60	0.46	0	1,034	18.4
92	37.93	8	94.7	0.3	0.0	47.0	60	0.83	0	1,044	18.0
93	38.05	8	97.4	0.3	0.0	47.1	60	0.98	0	1,026	17.8
94	38.17	8	97.9	0.3	0.0	46.9	60	0.75	0	1,030	17.9
95	38.29	8	95.1	0.3	0.0	46.9	60	0.44	0	1,050	18.0
96	38.41	8	93.9	0.3	0.0	47.0	60	0.34	0	1,046	17.9
97	38.54	8	94.2	0.3	0.0	47.1	60	0.33	0	1,069	18.4
109	40.00	8	95.5	0.3	0.0	49.4	60	0.81	0	1,056	18.7
110	40.12	8	96.5	0.3	0.0	49.5	60	1.18	0	1,080	18.9
111	40.24	8	99.1	0.3	0.0	49.6	60	1.42	0	1,119	19.4
112	40.37	8	97.5	0.3	0.0	49.6	60	1.07	0	1,110	19.0
113	40.49	8	93.5	0.3	0.0	49.3	60	1.35	0	1,041	18.8
114	40.61	8	91.0	0.3	0.0	49.4	60	0.66	0	1,091	17.7
115	40.73	8	99.7	0.3	0.0	49.4	60	0.78	0	1,084	19.6
116	40.85	8	97.6	0.3	0.0	49.5	60	1.32	0	1,114	19.7
117	40.98	8	97.9	0.3	0.0	49.4	60	1.24	0	1,070	19.5
118	41.10	8	93.1	0.3	0.0	49.5	60	1.26	0	1,055	18.9
119	41.22	8	97.5	0.3	0.0	49.5	60	1.29	0	1,133	19.6
120	41.34	8	96.8	0.3	0.0	49.3	60	1.29	0	1,134	19.2
121	41.46	8	94.7	0.3	0.0	49.5	60	0.79	0	1,107	18.4
122	41.59	8	94.3	0.3	0.0	49.4	60	0.55	0	1,044	17.9
123	41.71	8	96.3	0.3	0.0	49.4	60	2.00	0	1,073	19.4
124	41.83	8	98.9	0.3	0.0	49.4	60	0.68	0	1,114	19.0
125	41.95	8	95.9	0.3	0.0	49.5	60	0.66	0	1,092	18.4
126	42.07	8	98.3	0.3	0.0	49.4	60	1.12	0	1,069	18.3
127	42.20	8	95.6	0.3	0.0	49.3	60	1.41	0	1,075	18.0
128	42.32	8	96.9	0.3	0.0	49.6	60	0.84	0	1,079	18.1
129	42.44	8	94.7	0.3	0.0	49.6	60	0.47	0	1,146	18.5
Average			94.2	0.3	0.0	46.8	60	0.96	0	1,064	18.0
Std. Dev.			4.2	0.0	0.0	2.2	0	0.34	0	52	0.7

Total number of blows analyzed: 94

WSSC-7-01 - TEST BORING B-6 25FT  
OP: WMN

TRUCK NO. 5  
Date: 30-May-2015

BL# Sensors

10-129 F3: [SPT B1] 217.8 (1.00); F4: [SPT B2] 218.9 (1.00); A3: [K0232] 290.0 (1.00);  
A4: [K0231] 325.0 (1.00)

BL# Comments

31 N: 8,10,11  
38 LE = 35.10 ft; WC = 16,715.9 f/s  
58 5, 7, 14  
68 LE = 40.10 ft; WC = 16,794.3 f/s  
97 N: 8,13,17  
109 LE = 45.10 ft; WC = 16,714.3 f/s  
129 N: 10,10,11

Time Summary

Drive 29 seconds	4:13 PM - 4:13 PM (5/30/2015) BN 10 - 31
Stop 37 minutes 37 seconds	4:13 PM - 4:51 PM
Drive 25 seconds	4:51 PM - 4:51 PM BN 38 - 58
Stop 23 minutes 16 seconds	4:51 PM - 5:14 PM
Drive 37 seconds	5:14 PM - 5:15 PM BN 68 - 97
Stop 26 minutes 48 seconds	5:15 PM - 5:42 PM
Drive 24 seconds	5:42 PM - 5:42 PM BN 109 - 129

Total time [01:29:38] = (Driving [00:01:55] + Stop [01:27:43])

## **APPENDIX B**

## **APPENDIX B**

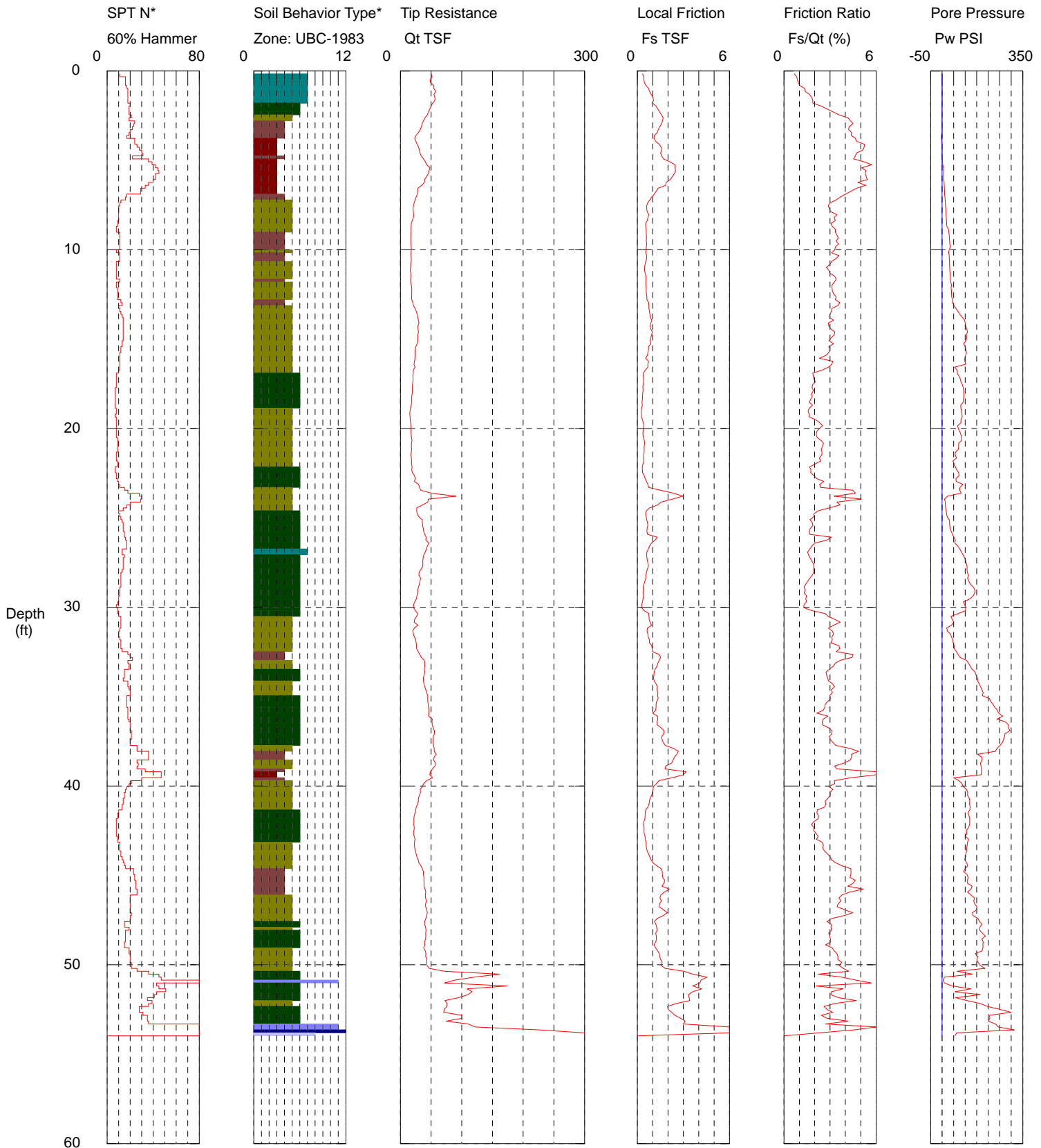
### **CONE PENETROMETER TESTING**

Oregon Geotechnical Explorations performed one CPT probe (CPT-1) on September 16, 2015 using a seismic electronic cone penetrometer to a depth of approximately 54 feet BGS where refusal was met in the stiff clay. Shear wave velocity tests were completed at 1-meter intervals. The approximate location of the probe is shown on Figure 2. The CPT log is presented in this appendix.

# GeoDesign / CPT-1 / 7775 NW Kaiser Rd.Ptld

Operator: OGE TAJ  
Sounding: CPT-1  
Cone Used: DPG1211

CPT Date/Time: 9/16/2015 10:44:07 AM  
Location: GeoDesign / CPT-1 / 7775 NW Kaiser Rd Ptld  
Job Number: 15067 / GeoDesign / CPT-1 / 7775 NW Kaiser Rd Ptld



Maximum Depth = 53.97 feet

Depth Increment = 0.164 feet

- |                          |                             |                            |                                |
|--------------------------|-----------------------------|----------------------------|--------------------------------|
| 1 sensitive fine grained | 4 silty clay to clay        | 7 silty sand to sandy silt | 10 gravelly sand to sand       |
| 2 organic material       | 5 clayey silt to silty clay | 8 sand to silty sand       | 11 very stiff fine grained (*) |
| 3 clay                   | 6 sandy silt to clayey silt | 9 sand                     | 12 sand to clayey sand (*)     |

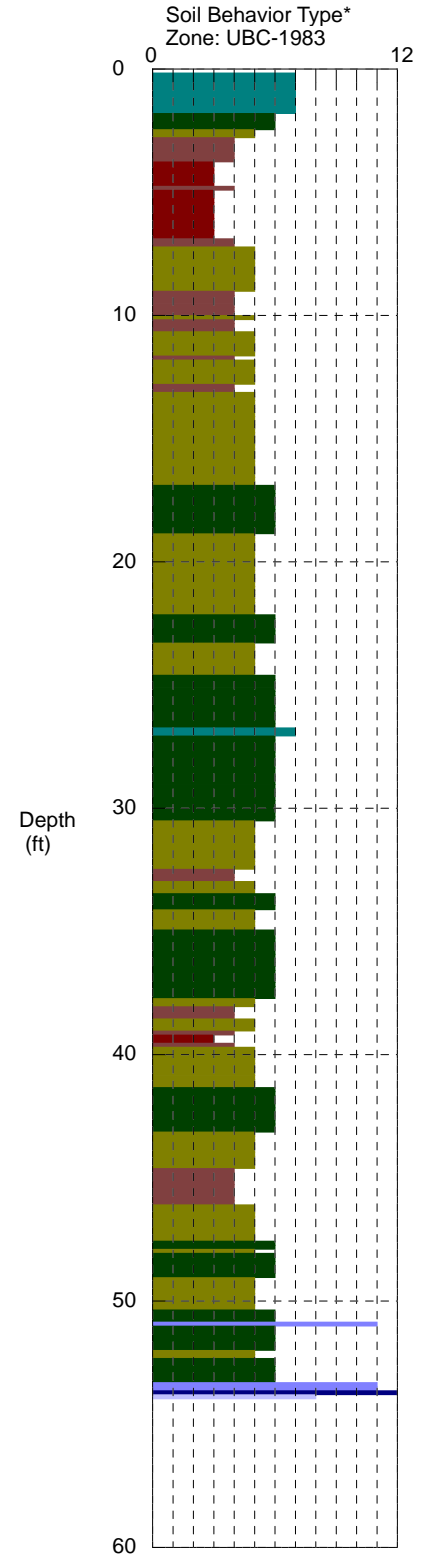
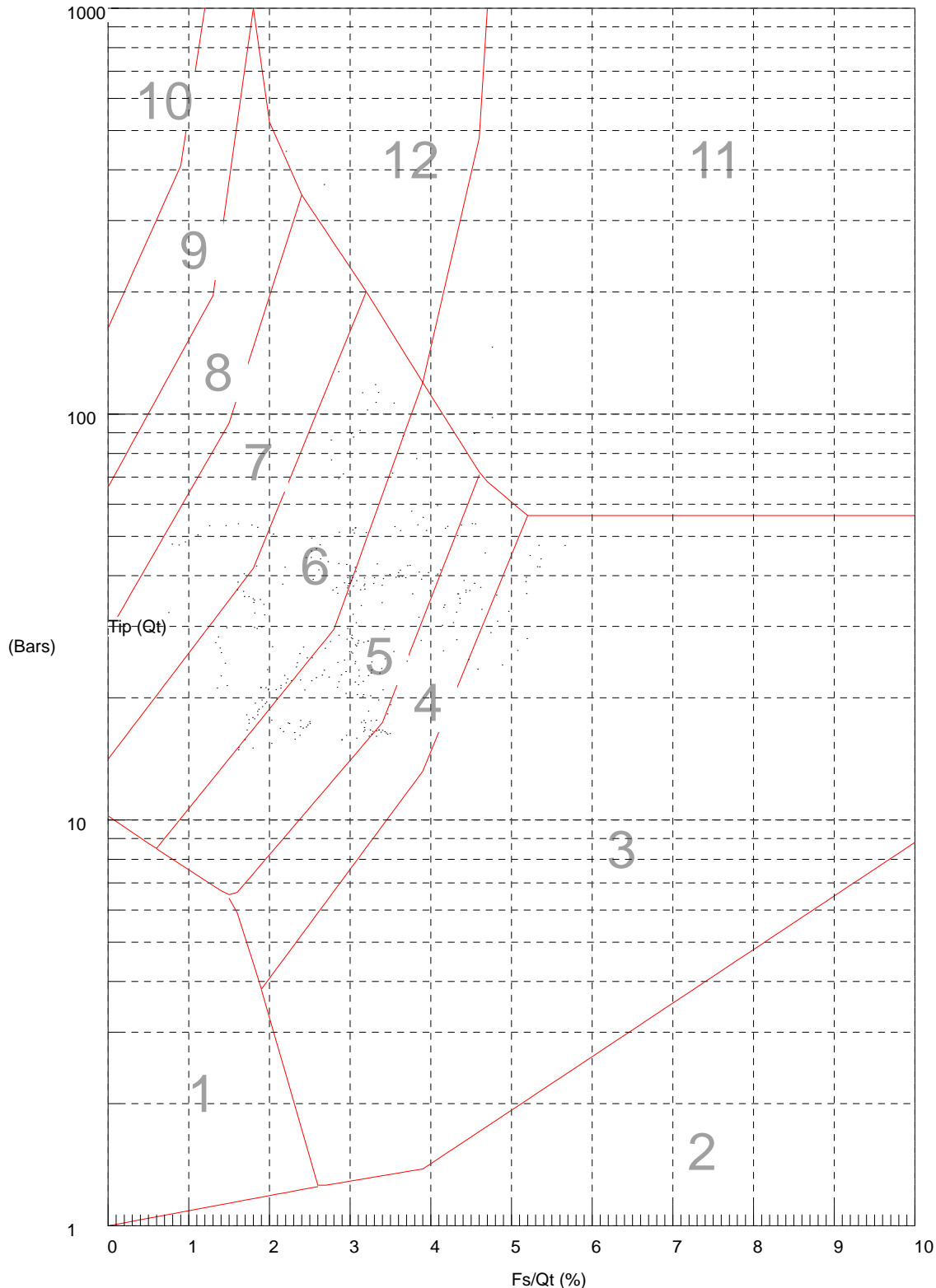
\*Soil behavior type and SPT based on data from UBC-1983

# GeoDesign / CPT-1 / 7775 NW Kaiser Rd.Ptld

Operator: OGE TAJ  
Sounding: CPT-1  
Cone Used: DPG1211

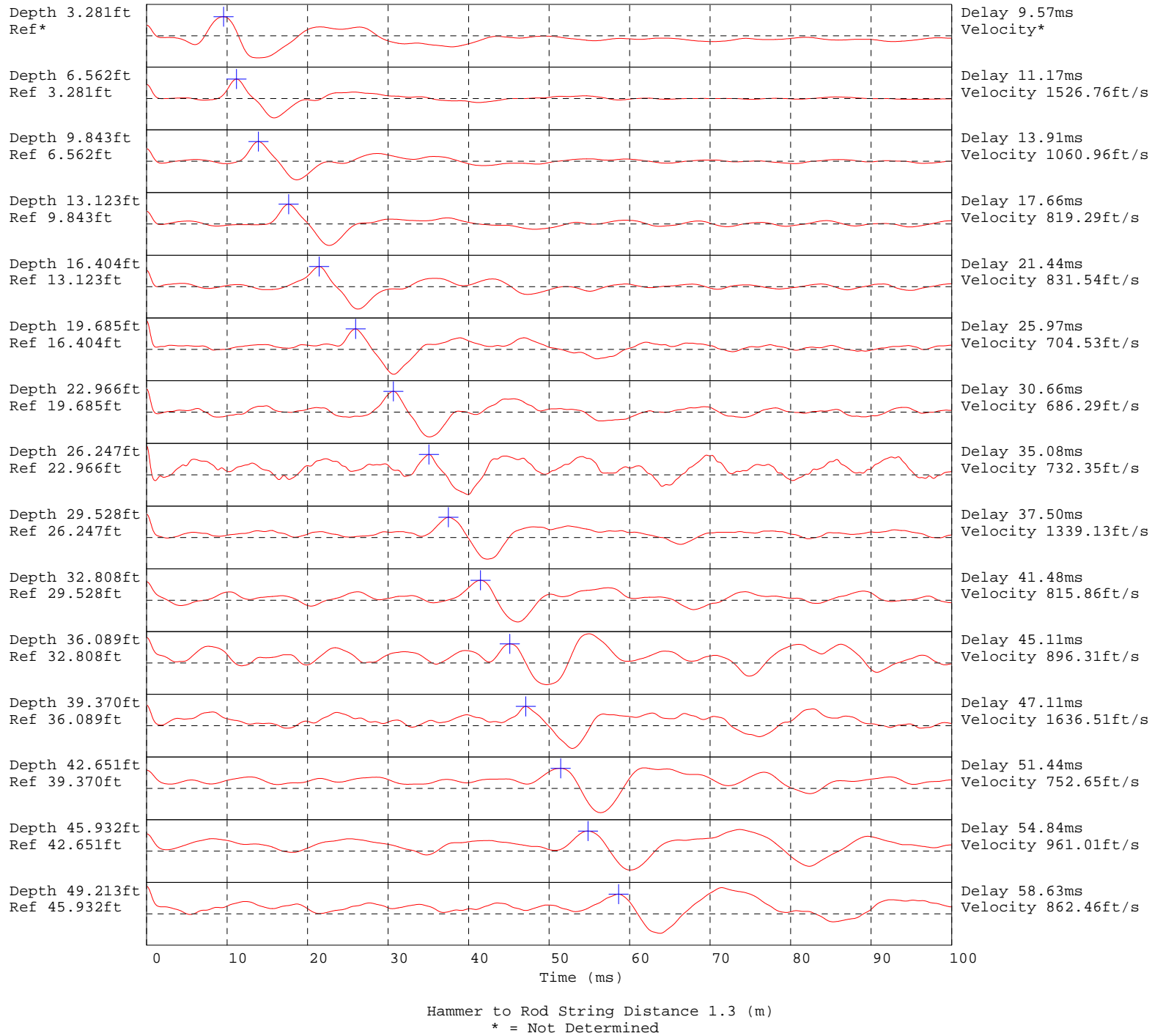
CPT Date/Time: 9/16/2015 10:44:07 AM  
Location: GeoDesign / CPT-1 / 7775 NW Kaiser Rd Ptld  
Job Number: 15067 / GeoDesign / CPT-1 / 7775 NW Kaiser Rd Ptld

Classification Data:  
Robertson and Campanella UBC-1983



- |                          |                             |                            |                                |
|--------------------------|-----------------------------|----------------------------|--------------------------------|
| 1 sensitive fine grained | 4 silty clay to clay        | 7 silty sand to sandy silt | 10 gravelly sand to sand       |
| 2 organic material       | 5 clayey silt to silty clay | 8 sand to silty sand       | 11 very stiff fine grained (*) |
| 3 clay                   | 6 sandy silt to clayey silt | 9 sand                     | 12 sand to clayey sand (*)     |

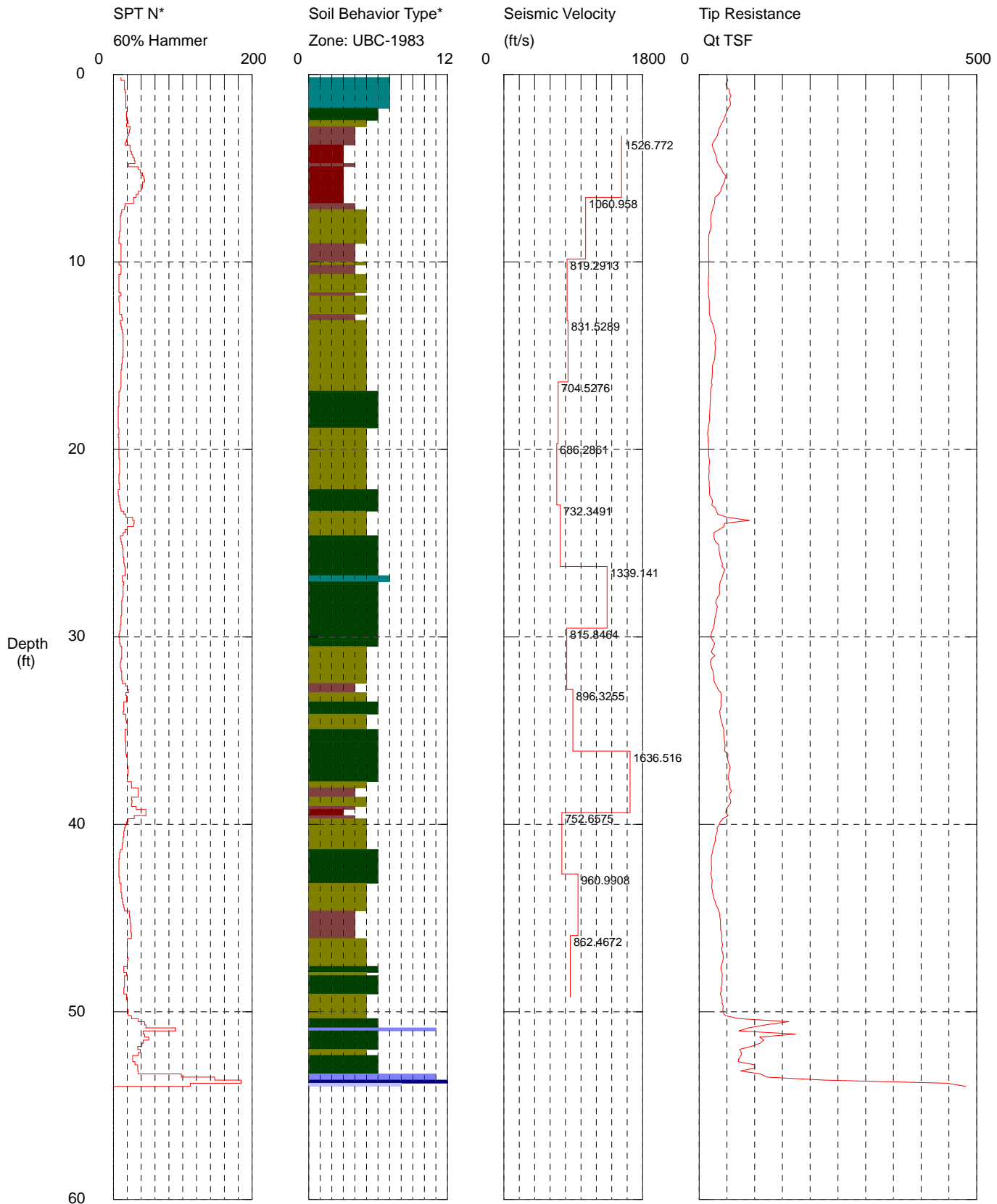
# GeoDesign / CPT-1 / 7775 NW Kaiser Rd Ptld



# GeoDesign / CPT-1 / 7775 NW Kaiser Rd.Ptld

Operator: OGE TAJ  
Sounding: CPT-1  
Cone Used: DPG1211

CPT Date/Time: 9/16/2015 10:44:07 AM  
Location: GeoDesign / CPT-1 / 7775 NW Kaiser Rd Ptld  
Job Number: 15067 / GeoDesign / CPT-1 / 7775 NW Kaiser Rd Ptld



Maximum Depth = 53.97 feet

Depth Increment = 0.164 feet

- |                          |                             |                            |                                |
|--------------------------|-----------------------------|----------------------------|--------------------------------|
| 1 sensitive fine grained | 4 silty clay to clay        | 7 silty sand to sandy silt | 10 gravelly sand to sand       |
| 2 organic material       | 5 clayey silt to silty clay | 8 sand to silty sand       | 11 very stiff fine grained (*) |
| 3 clay                   | 6 sandy silt to clayey silt | 9 sand                     | 12 sand to clayey sand (*)     |

Data File:CPT-19/16/2015 10:44:07 AM  
Operator:OGE TAJLocation:GeoDesign / CPT-1 / 7775 NW Kaiser Rd Ptld  
Cone ID:DPG1211Job Number:15067 / GeoDesign / CPT-1 / 7775 NW Kaiser Rd Pt  
Customer:Units:

Depth (ft)	Qt TSF	Fs TSF	Fs/Qt (%)	Pw PSI	SPT N* 60% Hammer	Zone	Soil Behavior Type UBC-1983
0.16	49.90	0.3398	0.681	0.260	11	7	silty sand to sandy silt
0.33	51.76	0.4230	0.817	0.269	16	7	silty sand to sandy silt
0.49	48.23	0.4249	0.881	-0.047	16	7	silty sand to sandy silt
0.66	49.15	0.4602	0.936	-0.105	16	7	silty sand to sandy silt
0.82	54.39	0.5645	1.038	0.051	17	7	silty sand to sandy silt
0.98	54.42	0.7295	1.341	0.076	18	7	silty sand to sandy silt
1.15	57.59	0.7970	1.384	0.125	18	7	silty sand to sandy silt
1.31	54.48	0.9014	1.655	0.071	18	7	silty sand to sandy silt
1.48	56.16	1.0135	1.805	0.164	18	7	silty sand to sandy silt
1.64	56.39	1.0568	1.874	0.132	18	7	silty sand to sandy silt
1.80	52.26	0.9812	1.878	-0.240	20	6	sandy silt to clayey silt
1.97	50.07	1.2125	2.422	0.020	19	6	sandy silt to clayey silt
2.46	43.68	1.5722	3.599	-0.338	21	5	clayey silt to silty clay
2.62	40.22	1.6813	4.180	-0.605	19	5	clayey silt to silty clay
2.79	37.68	1.6342	4.337	-0.287	24	4	silty clay to clay
2.95	35.20	1.5826	4.495	0.042	23	4	silty clay to clay
3.12	34.27	1.4546	4.245	0.064	22	4	silty clay to clay
3.28	32.42	1.3616	4.200	0.404	20	4	silty clay to clay
3.44	29.36	1.2919	4.400	0.012	19	4	silty clay to clay
3.61	25.37	1.1110	4.379	-3.598	17	4	silty clay to clay
3.77	23.19	1.0791	4.653	-3.639	24	3	clay
3.94	25.13	1.1868	4.723	-1.560	24	3	clay
4.10	27.16	1.4213	5.233	-0.284	26	3	clay
4.27	29.64	1.5493	5.227	-0.100	28	3	clay
4.43	30.91	1.5828	5.121	0.323	30	3	clay
4.59	32.01	1.5110	4.721	0.017	31	3	clay
4.76	33.92	1.5782	4.653	0.103	22	4	silty clay to clay
4.92	37.59	1.7050	4.535	0.786	36	3	clay
5.09	40.68	2.1164	5.203	1.587	39	3	clay
5.25	42.88	2.4512	5.717	2.714	42	3	clay
5.41	48.33	2.4480	5.065	5.991	44	3	clay
5.58	46.64	2.4930	5.345	6.777	45	3	clay
5.74	45.61	2.4100	5.283	6.983	42	3	clay
6.07	39.54	2.1460	5.428	7.286	40	3	clay
6.23	39.04	1.8784	4.811	8.168	36	3	clay
6.40	34.67	1.8471	5.328	9.251	33	3	clay
6.56	28.66	1.3551	4.728	10.034	29	3	clay
6.89	27.43	1.1009	4.014	10.776	17	4	silty clay to clay
7.05	25.74	0.9416	3.659	12.146	16	4	silty clay to clay
7.22	23.98	0.8152	3.399	13.106	12	5	clayey silt to silty clay
7.38	22.41	0.6715	2.996	13.750	11	5	clayey silt to silty clay
7.55	21.08	0.6056	2.872	14.786	10	5	clayey silt to silty clay
7.71	20.71	0.6153	2.971	15.795	10	5	clayey silt to silty clay
7.87	20.89	0.6357	3.043	16.549	10	5	clayey silt to silty clay
8.04	21.49	0.7396	3.442	17.215	10	5	clayey silt to silty clay
8.20	21.03	0.6862	3.263	18.053	10	5	clayey silt to silty clay
8.37	19.36	0.6474	3.344	18.866	9	5	clayey silt to silty clay
8.53	17.75	0.5420	3.053	19.616	9	5	clayey silt to silty clay
8.69	17.27	0.5436	3.148	20.243	8	5	clayey silt to silty clay
8.86	17.19	0.5743	3.341	27.453	8	5	clayey silt to silty clay
9.02	17.36	0.5810	3.347	29.113	11	4	silty clay to clay
9.19	17.02	0.5884	3.457	30.823	11	4	silty clay to clay
9.35	16.95	0.5996	3.537	31.619	11	4	silty clay to clay
9.51	17.03	0.5785	3.396	32.364	11	4	silty clay to clay
9.68	17.19	0.6092	3.544	33.169	11	4	silty clay to clay
9.84	17.48	0.5851	3.347	35.378	11	4	silty clay to clay
10.01	17.43	0.5769	3.310	30.301	8	5	clayey silt to silty clay
10.17	17.32	0.5348	3.088	27.984	11	4	silty clay to clay

\*Soil behavior type and SPT based on data from UBC-1983

Depth (ft)	Qt TSF	Fs TSF	Fs/Qt (%)	Pw PSI	SPT N* 60% Hammer	Zone	Soil Behavior Type UBC-1983
10.33	17.18	0.6155	3.582	30.772	11	4	silty clay to clay
10.50	17.73	0.6021	3.396	31.212	11	4	silty clay to clay
10.66	17.31	0.5355	3.094	32.420	8	5	clayey silt to silty clay
10.83	16.71	0.5007	2.996	31.842	8	5	clayey silt to silty clay
10.99	16.64	0.4594	2.760	32.684	8	5	clayey silt to silty clay
11.15	15.96	0.4673	2.928	33.235	8	5	clayey silt to silty clay
11.32	16.84	0.5057	3.003	34.431	8	5	clayey silt to silty clay
11.48	17.09	0.5638	3.299	35.310	8	5	clayey silt to silty clay
11.65	16.47	0.5600	3.401	35.582	11	4	silty clay to clay
11.81	16.81	0.5500	3.272	37.186	8	5	clayey silt to silty clay
11.98	17.77	0.5569	3.134	40.945	8	5	clayey silt to silty clay
12.14	18.36	0.5739	3.125	38.499	9	5	clayey silt to silty clay
12.30	18.40	0.5799	3.152	40.480	9	5	clayey silt to silty clay
12.47	18.35	0.5929	3.231	40.715	9	5	clayey silt to silty clay
12.63	18.27	0.6201	3.395	41.433	9	5	clayey silt to silty clay
12.80	18.60	0.6213	3.340	44.235	12	4	silty clay to clay
12.96	20.34	0.7384	3.631	45.643	13	4	silty clay to clay
13.12	21.30	0.7478	3.511	51.301	10	5	clayey silt to silty clay
13.29	23.92	0.7458	3.118	59.718	11	5	clayey silt to silty clay
13.45	25.86	0.7983	3.087	68.707	12	5	clayey silt to silty clay
13.62	27.22	0.8150	2.994	76.495	13	5	clayey silt to silty clay
13.78	28.13	0.8339	2.964	87.492	14	5	clayey silt to silty clay
13.94	29.27	0.9435	3.224	97.576	14	5	clayey silt to silty clay
14.11	30.17	0.8730	2.894	100.118	14	5	clayey silt to silty clay
14.27	28.67	0.8384	2.924	102.506	14	5	clayey silt to silty clay
14.44	28.62	0.8760	3.061	106.642	14	5	clayey silt to silty clay
14.60	29.46	0.9761	3.313	110.284	14	5	clayey silt to silty clay
14.76	28.45	0.9303	3.270	104.921	14	5	clayey silt to silty clay
14.93	28.58	0.8800	3.079	106.650	14	5	clayey silt to silty clay
15.09	28.37	0.8320	2.933	104.010	13	5	clayey silt to silty clay
15.26	27.23	0.8785	3.227	93.583	13	5	clayey silt to silty clay
15.42	25.12	0.7326	2.916	100.130	12	5	clayey silt to silty clay
15.58	23.76	0.7163	3.015	102.423	12	5	clayey silt to silty clay
15.75	23.80	0.6929	2.911	105.829	11	5	clayey silt to silty clay
15.91	23.79	0.6529	2.744	102.160	11	5	clayey silt to silty clay
16.08	23.65	0.5445	2.302	97.769	11	5	clayey silt to silty clay
16.24	23.04	0.7317	3.176	98.176	11	5	clayey silt to silty clay
16.40	21.94	0.6851	3.122	103.623	11	5	clayey silt to silty clay
16.57	23.61	0.6827	2.892	54.120	11	5	clayey silt to silty clay
16.73	20.99	0.5208	2.482	65.104	10	5	clayey silt to silty clay
16.90	20.89	0.3914	1.874	65.398	8	6	sandy silt to clayey silt
17.06	20.29	0.3862	1.903	72.449	8	6	sandy silt to clayey silt
17.22	20.69	0.4011	1.939	78.927	8	6	sandy silt to clayey silt
17.39	20.24	0.4137	2.044	81.911	8	6	sandy silt to clayey silt
17.55	19.78	0.3670	1.856	87.842	8	6	sandy silt to clayey silt
17.72	19.59	0.3589	1.832	91.445	7	6	sandy silt to clayey silt
17.88	19.35	0.3711	1.918	93.596	7	6	sandy silt to clayey silt
18.04	19.08	0.3437	1.802	93.456	7	6	sandy silt to clayey silt
18.21	18.49	0.3402	1.840	94.852	7	6	sandy silt to clayey silt
18.37	18.47	0.3200	1.732	92.540	7	6	sandy silt to clayey silt
18.54	18.42	0.3048	1.655	90.586	7	6	sandy silt to clayey silt
18.70	17.35	0.3212	1.852	80.750	7	6	sandy silt to clayey silt
18.86	16.47	0.2723	1.653	81.416	8	5	clayey silt to silty clay
19.03	15.59	0.2442	1.567	83.147	8	5	clayey silt to silty clay
19.19	15.17	0.2473	1.630	86.454	7	5	clayey silt to silty clay
19.36	15.89	0.2615	1.646	87.313	8	5	clayey silt to silty clay
19.52	16.09	0.3369	2.093	81.656	8	5	clayey silt to silty clay
19.69	16.39	0.3814	2.327	81.788	8	5	clayey silt to silty clay
19.85	17.04	0.4278	2.511	66.784	8	5	clayey silt to silty clay
20.01	17.22	0.3940	2.288	70.806	8	5	clayey silt to silty clay
20.18	17.21	0.3670	2.133	76.202	8	5	clayey silt to silty clay
20.34	17.33	0.3634	2.097	81.592	8	5	clayey silt to silty clay
20.51	18.12	0.3924	2.165	85.572	9	5	clayey silt to silty clay

\*Soil behavior type and SPT based on data from UBC-1983

Depth (ft)	Qt TSF	Fs TSF	Fs/Qt (%)	Pw PSI	SPT N* 60% Hammer	Zone	Soil Behavior Type UBC-1983
20.67	18.86	0.4556	2.416	85.268	9	5	clayey silt to silty clay
20.83	18.13	0.4662	2.572	71.431	9	5	clayey silt to silty clay
21.00	17.73	0.4449	2.510	71.903	9	5	clayey silt to silty clay
21.16	18.26	0.4427	2.425	70.544	9	5	clayey silt to silty clay
21.33	17.76	0.4415	2.485	57.208	8	5	clayey silt to silty clay
21.49	17.07	0.4200	2.460	56.760	8	5	clayey silt to silty clay
21.65	17.93	0.4132	2.304	62.809	8	5	clayey silt to silty clay
21.82	18.17	0.4348	2.394	46.740	9	5	clayey silt to silty clay
21.98	18.10	0.3693	2.040	52.060	9	5	clayey silt to silty clay
22.15	18.97	0.3148	1.659	57.039	7	6	sandy silt to clayey silt
22.31	18.54	0.3243	1.750	63.162	7	6	sandy silt to clayey silt
22.47	19.39	0.3371	1.738	71.325	8	6	sandy silt to clayey silt
22.64	22.87	0.4461	1.951	73.620	8	6	sandy silt to clayey silt
22.80	24.13	0.5140	2.130	59.674	9	6	sandy silt to clayey silt
22.97	22.74	0.5908	2.598	60.987	10	6	sandy silt to clayey silt
23.13	29.61	0.6873	2.321	90.463	11	6	sandy silt to clayey silt
23.29	31.21	0.7438	2.383	77.267	15	5	clayey silt to silty clay
23.46	33.32	1.4921	4.478	76.738	18	5	clayey silt to silty clay
23.62	50.67	2.3611	4.660	82.398	28	5	clayey silt to silty clay
23.79	90.38	2.9517	3.266	23.240	30	5	clayey silt to silty clay
23.95	45.52	2.2976	5.047	10.284	29	5	clayey silt to silty clay
24.11	44.71	1.5405	3.445	13.520	20	5	clayey silt to silty clay
24.28	36.16	1.3215	3.655	13.772	17	5	clayey silt to silty clay
24.44	26.67	0.7874	2.952	15.160	14	5	clayey silt to silty clay
24.61	26.56	0.5924	2.230	17.421	10	6	sandy silt to clayey silt
24.77	27.29	0.5322	1.950	19.591	11	6	sandy silt to clayey silt
24.93	29.91	0.5806	1.941	21.812	12	6	sandy silt to clayey silt
25.10	35.67	0.6012	1.686	30.475	13	6	sandy silt to clayey silt
25.26	35.84	0.6590	1.839	32.207	14	6	sandy silt to clayey silt
25.43	36.14	0.6811	1.885	32.785	14	6	sandy silt to clayey silt
25.59	37.12	0.6362	1.714	34.379	14	6	sandy silt to clayey silt
25.75	37.98	0.6218	1.637	39.647	15	6	sandy silt to clayey silt
25.92	39.55	0.6641	1.679	44.869	15	6	sandy silt to clayey silt
26.08	41.88	1.2956	3.093	51.235	16	6	sandy silt to clayey silt
26.25	41.37	1.1590	2.801	57.943	17	6	sandy silt to clayey silt
26.41	46.27	0.9244	1.998	55.143	17	6	sandy silt to clayey silt
26.57	43.86	0.7967	1.817	67.936	17	6	sandy silt to clayey silt
26.74	42.26	0.7133	1.688	76.843	13	7	silty sand to sandy silt
26.90	40.54	0.6231	1.537	84.051	13	7	silty sand to sandy silt
27.07	37.99	0.6051	1.593	91.186	15	6	sandy silt to clayey silt
27.23	37.05	0.6230	1.682	97.024	14	6	sandy silt to clayey silt
27.40	36.36	0.6530	1.796	102.031	14	6	sandy silt to clayey silt
27.56	36.54	0.6982	1.911	105.273	14	6	sandy silt to clayey silt
27.72	36.61	0.7125	1.946	108.445	14	6	sandy silt to clayey silt
27.89	33.30	0.6412	1.926	108.168	13	6	sandy silt to clayey silt
28.05	30.37	0.5900	1.943	109.312	12	6	sandy silt to clayey silt
28.22	30.08	0.5518	1.834	115.097	12	6	sandy silt to clayey silt
28.38	32.96	0.5507	1.671	109.861	12	6	sandy silt to clayey silt
28.71	30.82	0.4354	1.413	122.097	12	6	sandy silt to clayey silt
28.87	29.52	0.3842	1.302	135.518	11	6	sandy silt to clayey silt
29.04	28.19	0.3888	1.380	141.796	11	6	sandy silt to clayey silt
29.20	28.08	0.3692	1.315	141.080	11	6	sandy silt to clayey silt
29.36	26.88	0.3957	1.472	134.899	10	6	sandy silt to clayey silt
29.53	26.03	0.3702	1.422	121.421	10	6	sandy silt to clayey silt
29.69	23.36	0.3402	1.456	92.087	9	6	sandy silt to clayey silt
29.86	21.58	0.2819	1.306	97.362	8	6	sandy silt to clayey silt
30.02	21.38	0.2736	1.280	101.805	9	6	sandy silt to clayey silt
30.18	24.23	0.4347	1.794	101.705	9	6	sandy silt to clayey silt
30.35	27.95	0.7433	2.660	70.720	10	6	sandy silt to clayey silt
30.51	26.43	0.7605	2.878	37.957	12	5	clayey silt to silty clay
30.68	23.25	0.7688	3.306	44.041	12	5	clayey silt to silty clay
30.84	22.42	0.8195	3.656	50.740	12	5	clayey silt to silty clay
31.00	28.31	0.9192	3.247	39.868	12	5	clayey silt to silty clay

\*Soil behavior type and SPT based on data from UBC-1983

Depth (ft)	Qt TSF	Fs TSF	Fs/Qt (%)	Pw PSI 60% Hammer	SPT N*	Zone	Soil Behavior Type UBC-1983
31.17	22.63	0.6558	2.898	19.760	11	5	clayey silt to silty clay
31.33	19.97	0.6297	3.153	22.775	10	5	clayey silt to silty clay
31.50	21.20	0.6838	3.226	36.471	10	5	clayey silt to silty clay
31.66	22.68	0.7069	3.117	40.637	11	5	clayey silt to silty clay
31.82	24.94	0.7839	3.143	45.944	12	5	clayey silt to silty clay
31.99	25.61	0.7842	3.062	48.251	12	5	clayey silt to silty clay
32.15	26.25	0.9410	3.586	51.898	12	5	clayey silt to silty clay
32.32	26.35	0.9585	3.637	52.817	13	5	clayey silt to silty clay
32.48	28.88	0.9837	3.406	61.739	18	4	silty clay to clay
32.64	31.57	1.4227	4.506	69.030	20	4	silty clay to clay
32.81	34.15	1.5119	4.428	77.945	22	4	silty clay to clay
32.97	39.04	1.4221	3.643	105.501	18	5	clayey silt to silty clay
33.14	39.91	1.3308	3.335	114.651	19	5	clayey silt to silty clay
33.30	39.74	1.2746	3.208	121.627	19	5	clayey silt to silty clay
33.46	38.84	1.1506	2.962	130.671	15	6	sandy silt to clayey silt
33.63	39.65	1.0877	2.744	143.344	15	6	sandy silt to clayey silt
33.79	38.67	1.0752	2.780	147.243	15	6	sandy silt to clayey silt
33.96	37.19	1.0539	2.834	153.006	14	6	sandy silt to clayey silt
34.12	37.55	1.0949	2.915	154.309	18	5	clayey silt to silty clay
34.28	38.35	1.2141	3.166	161.017	18	5	clayey silt to silty clay
34.45	39.78	1.3076	3.287	167.206	19	5	clayey silt to silty clay
34.61	41.33	1.2743	3.083	172.246	20	5	clayey silt to silty clay
34.78	42.52	1.3423	3.157	178.401	20	5	clayey silt to silty clay
34.94	44.57	1.3262	2.975	173.993	17	6	sandy silt to clayey silt
35.10	44.30	1.3533	3.055	205.421	17	6	sandy silt to clayey silt
35.27	44.64	1.2655	2.835	211.000	17	6	sandy silt to clayey silt
35.43	45.26	1.2141	2.683	221.144	17	6	sandy silt to clayey silt
35.60	45.72	1.2169	2.662	228.989	18	6	sandy silt to clayey silt
35.76	46.81	1.1941	2.551	239.523	18	6	sandy silt to clayey silt
35.93	46.36	0.9935	2.143	245.146	18	6	sandy silt to clayey silt
36.09	45.83	1.3079	2.854	263.111	18	6	sandy silt to clayey silt
36.25	52.01	1.3305	2.558	238.178	19	6	sandy silt to clayey silt
36.42	51.43	1.2789	2.487	275.097	20	6	sandy silt to clayey silt
36.58	51.68	1.3000	2.515	287.417	20	6	sandy silt to clayey silt
36.75	53.32	1.5549	2.916	287.917	20	6	sandy silt to clayey silt
36.91	55.42	1.7376	3.135	294.226	21	6	sandy silt to clayey silt
37.07	55.54	1.7337	3.121	272.856	21	6	sandy silt to clayey silt
37.24	53.60	1.5756	2.940	271.193	21	6	sandy silt to clayey silt
37.40	53.20	1.6113	3.029	266.621	20	6	sandy silt to clayey silt
37.57	52.86	1.6815	3.181	262.173	20	6	sandy silt to clayey silt
37.73	54.00	1.8250	3.380	251.394	26	5	clayey silt to silty clay
37.89	54.97	2.3541	4.282	238.396	26	5	clayey silt to silty clay
38.06	55.06	2.6730	4.855	230.836	36	4	silty clay to clay
38.22	58.32	2.5670	4.402	153.588	36	4	silty clay to clay
38.39	54.83	2.4165	4.407	172.381	36	4	silty clay to clay
38.55	53.91	2.3262	4.315	173.459	26	5	clayey silt to silty clay
38.71	57.07	2.2336	3.913	166.344	27	5	clayey silt to silty clay
38.88	56.28	1.8555	3.297	168.938	26	5	clayey silt to silty clay
39.04	52.17	1.7903	3.432	170.779	33	4	silty clay to clay
39.21	48.88	3.1675	6.479	170.672	47	3	clay
39.37	47.76	2.9864	6.253	169.726	47	3	clay
39.53	52.14	2.2704	4.355	50.169	30	4	silty clay to clay
39.70	42.62	1.4008	3.287	72.312	21	5	clayey silt to silty clay
39.86	37.84	1.2486	3.300	86.255	19	5	clayey silt to silty clay
40.03	35.72	1.0438	2.922	91.044	17	5	clayey silt to silty clay
40.19	32.26	1.0261	3.181	105.190	16	5	clayey silt to silty clay
40.35	32.64	0.9830	3.011	111.078	15	5	clayey silt to silty clay
40.52	31.10	0.9418	3.028	110.434	15	5	clayey silt to silty clay
40.68	29.15	0.8317	2.853	117.870	14	5	clayey silt to silty clay
40.85	29.16	0.7835	2.687	119.454	14	5	clayey silt to silty clay
41.01	27.91	0.7584	2.717	118.688	13	5	clayey silt to silty clay
41.17	25.94	0.6900	2.660	121.504	13	5	clayey silt to silty clay
41.34	24.75	0.5377	2.172	120.302	10	6	sandy silt to clayey silt

\*Soil behavior type and SPT based on data from UBC-1983

Depth (ft)	Qt TSF	Fs TSF	Fs/Qt (%)	Pw PSI	SPT N* 60% Hammer	Zone	Soil Behavior Type UBC-1983
41.50	23.94	0.5124	2.140	111.715	9	6	sandy silt to clayey silt
41.67	22.47	0.5055	2.250	116.684	9	6	sandy silt to clayey silt
41.83	21.85	0.4867	2.227	119.523	8	6	sandy silt to clayey silt
41.99	21.96	0.4258	1.939	119.834	8	6	sandy silt to clayey silt
42.16	21.77	0.3881	1.783	119.138	8	6	sandy silt to clayey silt
42.32	22.65	0.4424	1.953	115.161	8	6	sandy silt to clayey silt
42.49	22.10	0.4266	1.930	104.597	8	6	sandy silt to clayey silt
42.65	21.14	0.4400	2.081	107.578	8	6	sandy silt to clayey silt
42.81	22.41	0.4997	2.230	100.978	9	6	sandy silt to clayey silt
42.98	23.66	0.4993	2.110	114.801	9	6	sandy silt to clayey silt
43.14	22.99	0.5697	2.478	110.238	11	5	clayey silt to silty clay
43.31	22.67	0.5816	2.565	108.759	11	5	clayey silt to silty clay
43.47	23.37	0.5893	2.522	106.571	11	5	clayey silt to silty clay
43.64	24.23	0.6414	2.648	106.476	12	5	clayey silt to silty clay
43.80	25.66	0.7305	2.846	102.503	12	5	clayey silt to silty clay
43.96	26.73	0.8071	3.020	102.217	13	5	clayey silt to silty clay
44.13	28.92	0.8945	3.093	97.402	14	5	clayey silt to silty clay
44.29	30.24	1.0173	3.365	106.505	15	5	clayey silt to silty clay
44.46	33.32	1.2522	3.758	111.090	16	5	clayey silt to silty clay
44.62	35.48	1.5429	4.348	100.213	23	4	silty clay to clay
44.78	37.25	1.6274	4.368	93.542	23	4	silty clay to clay
44.95	37.41	1.6291	4.355	107.994	24	4	silty clay to clay
45.11	38.35	1.6486	4.299	112.413	24	4	silty clay to clay
45.28	38.35	1.7801	4.642	110.186	25	4	silty clay to clay
45.44	38.53	1.7329	4.498	110.123	25	4	silty clay to clay
45.60	38.53	1.6025	4.159	130.187	25	4	silty clay to clay
45.77	40.20	2.0781	5.169	125.362	26	4	silty clay to clay
45.93	41.34	1.7713	4.284	110.473	26	4	silty clay to clay
46.10	40.40	1.5261	3.778	125.229	20	5	clayey silt to silty clay
46.26	41.08	1.4698	3.578	140.593	20	5	clayey silt to silty clay
46.42	42.40	1.5703	3.704	137.186	20	5	clayey silt to silty clay
46.59	40.92	1.4414	3.522	141.534	20	5	clayey silt to silty clay
46.75	40.94	1.4174	3.462	150.307	20	5	clayey silt to silty clay
46.92	42.95	1.6895	3.934	151.186	20	5	clayey silt to silty clay
47.08	43.62	1.9532	4.478	131.024	21	5	clayey silt to silty clay
47.24	42.99	1.6917	3.935	134.406	20	5	clayey silt to silty clay
47.41	41.32	1.2833	3.106	156.126	20	5	clayey silt to silty clay
47.57	39.57	1.1116	2.809	161.908	15	6	sandy silt to clayey silt
47.74	39.25	1.2058	3.072	172.376	15	6	sandy silt to clayey silt
47.90	41.00	1.2562	3.064	164.027	19	5	clayey silt to silty clay
48.06	41.64	1.2901	3.098	163.461	16	6	sandy silt to clayey silt
48.23	41.25	1.2006	2.910	174.485	16	6	sandy silt to clayey silt
48.39	41.41	1.2327	2.977	187.448	16	6	sandy silt to clayey silt
48.56	41.22	1.2442	3.018	172.388	16	6	sandy silt to clayey silt
48.72	39.27	1.1977	3.050	178.382	15	6	sandy silt to clayey silt
48.88	39.76	1.0788	2.713	176.741	15	6	sandy silt to clayey silt
49.05	37.89	1.1895	3.139	177.475	19	5	clayey silt to silty clay
49.21	40.43	1.3193	3.263	173.794	19	5	clayey silt to silty clay
49.38	41.49	1.4317	3.451	144.125	20	5	clayey silt to silty clay
49.54	41.29	1.4492	3.510	154.936	20	5	clayey silt to silty clay
49.70	43.39	1.5228	3.510	150.368	20	5	clayey silt to silty clay
49.87	42.82	1.6124	3.766	156.275	21	5	clayey silt to silty clay
50.03	43.18	1.5470	3.583	165.719	21	5	clayey silt to silty clay
50.20	47.01	1.8166	3.864	185.783	26	5	clayey silt to silty clay
50.36	71.77	3.0232	4.212	65.503	36	6	sandy silt to clayey silt
50.52	161.51	3.6076	2.234	132.467	45	6	sandy silt to clayey silt
50.69	120.61	4.5233	3.750	10.289	47	6	sandy silt to clayey silt
50.85	88.34	4.1392	4.686	4.240	90	11	very stiff fine grained (*)
51.02	71.82	4.0774	5.678	9.513	43	6	sandy silt to clayey silt
51.18	173.57	3.6032	2.076	42.817	45	6	sandy silt to clayey silt
51.35	108.90	4.1863	3.844	124.225	51	6	sandy silt to clayey silt
51.51	116.39	3.5980	3.091	56.172	43	6	sandy silt to clayey silt
51.67	109.65	3.3325	3.039	165.176	41	6	sandy silt to clayey silt

\*Soil behavior type and SPT based on data from UBC-1983

Depth (ft)	Qt TSF	Fs TSF	Fs/Qt (%)	Pw PSI	SPT N* 60% Hammer	Zone	Soil Behavior Type UBC-1983
51.84	94.69	3.3736	3.563	57.940	35	6	sandy silt to clayey silt
52.00	72.65	3.4130	4.698	107.943	39	5	clayey silt to silty clay
52.17	76.08	2.5185	3.310	165.511	36	5	clayey silt to silty clay
52.33	75.56	1.9697	2.607	196.608	28	6	sandy silt to clayey silt
52.49	71.44	2.0075	2.810	251.321	28	6	sandy silt to clayey silt
52.66	70.46	2.2318	3.168	299.234	31	6	sandy silt to clayey silt
52.82	99.76	2.4429	2.449	206.623	35	6	sandy silt to clayey silt
52.99	100.54	2.8057	2.791	207.125	35	6	sandy silt to clayey silt
53.15	74.61	3.1116	4.171	200.177	36	6	sandy silt to clayey silt
53.31	110.55	2.9975	2.711	231.909	98	11	very stiff fine grained (*)
53.48	122.11	8.5165	6.974	243.731	146	11	very stiff fine grained (*)
53.64	225.51	10.2906	4.563	312.396	184	12	sand to clayey sand (*)
53.81	447.32	10.2346	2.288	63.510	111	8	sand to silty sand
53.97	480.40	-32768	-32768	54.786	0	0	<out of range>

\*Soil behavior type and SPT based on data from UBC-1983

## APPENDIX C

## APPENDIX C

### SITE-SPECIFIC SEISMIC HAZARD EVALUATION

#### INTRODUCTION

The information in this appendix summarizes the results of a site-specific seismic hazard evaluation for the proposed Kaiser K5 school in Washington County, Oregon. This seismic hazard evaluation was performed in accordance with the requirements of the 2014 SOSSC and ASCE 7-10.

#### SITE CONDITIONS

##### *REGIONAL GEOLOGY*

A detailed description of the geologic setting is presented in the main report.

##### *SUBSURFACE CONDITIONS*

A detailed description of site subsurface conditions is presented in the main report.

##### *SEISMIC SETTING*

###### **Earthquake Source Zones**

Three scenario earthquakes were considered for this study consistent with the local seismic setting. Two of the possible earthquake sources are associated with the CSZ, and the third event is a shallow local crustal earthquake that could occur in the North American plate. The three earthquake scenarios are discussed below.

###### **Regional Events**

The CSZ is the region where the Juan de Fuca Plate is being subducted beneath the North American Plate. This subduction is occurring in the coastal region between Vancouver Island and northern California. Evidence has accumulated suggesting that this subduction zone has generated eight great earthquakes in the last 4,000 years, with the most recent event occurring approximately 300 years ago (Weaver and Shedlock, 1991). The fault trace is mapped approximately 50 to 120 km off the Oregon Coast. Two types of subduction zone earthquakes are possible and considered in this study:

1. An interface event earthquake on the seismogenic part of the interface between the Juan de Fuca Plate and the North American Plate on the CSZ. This source is reportedly capable of generating earthquakes with a moment magnitude of between 8.5 and 9.0.
2. A deep intraplate earthquake on the seismogenic part of the subducting Juan de Fuca Plate. These events typically occur at depths of between 30 and 60 km. This source is capable of generating an event with a moment magnitude of up to 7.5.

###### **Local Events**

A significant earthquake could occur on a local fault near the site within the design life of the facility. Such an event would cause ground shaking at the site that could be more intense than the CSZ events, though the duration would be shorter. Figure C-1 shows the locations of faults

with potential Quaternary movement within a 20-mile radius of the site. Figure C-2 shows the interpreted locations of seismic events that occurred between 1833 and 1993 (USGS, 2009). The most significant faults in the site vicinity are the Portland Hills fault, Oatfield fault, and Helvetia fault. A discussion of these faults is provided below.

### ***Portland Hills Fault***

The Portland Hills fault is mapped approximately 4.6 km east of the site. The northwest-striking Portland Hills fault forms the prominent linear northeastern margin of the Tualatin Mountains (Portland Hills) and the southwestern margin of the Portland Basin; this basin may be a right-lateral, pull-apart basin in the forearc of the CSZ or a piggyback synclinal basin formed between antiformal uplifts of the Portland fold belt. The fault is part of the Portland Hills-Clackamas River structural zone, which controlled the deposition of Miocene CRBG lavas in the region. The crest of the Portland Hills is defined by the northwest-striking Portland Hills anticline. Sense of displacement on the Portland Hills fault is poorly known and controversial. The fault was originally mapped as a down-to-the-northeast normal fault. The fault has also been mapped as part of a regional-scale zone of right-lateral oblique slip faults and as a steep escarpment caused by asymmetrical folding above a southwest-dipping blind thrust. Reverse displacement with a right-lateral, strike-slip component may be most consistent with the tectonic setting, mapped geologic relations, aeromagnetic data, and microseismicity in the area. Fault scarps on surficial Quaternary deposits have not been described along the fault trace, but some geomorphic (steep, linear escarpment, triangular facets, over-steepened, and knick-pointed tributaries) and geophysical (aeromagnetic, seismic reflection, and ground penetrating radar) evidence suggest Quaternary displacement (Personius, 2002).

### ***Oatfield Fault***

The northwest-striking Oatfield fault forms northeast-facing escarpments in volcanic rocks of the Miocene CRBG in the Tualatin Mountains and northern Willamette Valley. The fault may be part of the Portland Hills-Clackamas River structural zone. The Oatfield fault is primarily mapped as a very high-angle, reverse fault with apparent down-to-the-southwest displacement, but a few kilometer-long reach of the fault with down-to-the-northeast displacement is mapped in the vicinity of the Willamette River. This apparent change in displacement direction along strike may reflect a discontinuity in the fault trace or could reflect the right-lateral, strike-slip displacement that characterizes other parts of the Portland Hills-Clackamas River structural zone. The fault has also been modeled as a 70-degree, east-dipping reverse fault. Reverse displacement with a right-lateral, strike-slip component is consistent with the tectonic setting, mapped geologic relations, and microseismicity in the area. Fault scarps on surficial deposits have not been described, but exposures in a light rail tunnel showing offset of approximately 1 M<sub>a</sub> Boring Lava across the fault indicate Quaternary displacement (Personius, 2002).

### ***Helvetia Fault***

The northwest-striking Helvetia fault forms part of the northeastern margin of the Tualatin Basin in northwestern Oregon. The fault primarily is mapped in the subsurface on the basis of water well data and has little aeromagnetic expression. The fault is expressed in the subsurface with down-to-the-southwest separation, but no data on fault dip or direction have been described.

Most of the fault trace is covered by a thick sequence of silty sediment deposited by the Missoula floods, which may bury evidence of pre-latest Quaternary displacement (Personius, 2002).

**Table C-1. Significant Crustal Faults**

Source	Closest Mapped Distance <sup>1</sup> (km)	Mapped Length <sup>1</sup> (km)
Portland Hills fault	4.6	24
Oatfield fault	1.5	49
Helvetia fault	7.0	29

1. Reported by USGS (USGS, 2014)

## SEISMIC RESPONSE ANALYSIS

### ***RISK TARGETED BEDROCK SPECTRUM***

We obtained a probabilistic bedrock spectrum for the site from the USGS national seismic mapping project. We determined the spectral accelerations for the outcropping bedrock response spectrum for periods ranging from 0 to 5 seconds. The response spectrum is consistent with a shear wave velocity equal to 760 meters per second in the upper 30 meters of the soil profile. ASCE 7-10 requires that the ground motions be defined in terms of the maximum direction of horizontal response. The maximum direction was adopted as the ground motion intensity parameter for use in lieu of explicit consideration of directional effects. The maximum horizontal response may reasonably be estimated by factoring the average response period by period dependent factors. The commentary to ASCE 7-10 recommends a factor of 1.1 at short periods, 1.3 at a period of 1 second, and 1.5 at 5 seconds and greater. They recommend interpolation between the periods.

The risk targeted bedrock spectrum,  $MCE_R$ , target bedrock spectrum was computed using Method 1 outlined in the ASCE 7-10 Section 21.2.1.1. A risk coefficient of  $C_{RS} = 0.898$  was applied to the spectrum at periods of 0.2 second or less and a risk coefficient of  $C_{R1} = 0.867$  was applied to the spectrum at periods greater than or equal to 1 second. Linear interpolation was used to compute risk coefficients between periods of 0.2 and 1.0 second. The intent of this is to achieve a 1 percent collapse of the structure in a 50-year period. Table C-2 presents a summary of values used to compute the  $MCE_R$  target bedrock response spectrum.

**Table C-2. Risk Targeted Bedrock Spectrum**

Period (seconds)	MCE Target Bedrock Spectral Acceleration (g)	Maximum Direction Factor	$C_R$	MCE <sub>R</sub> Target Bedrock Spectral Acceleration (g)
0.0	0.46220	1.1	0.898	0.457
0.1	0.95960	1.1	0.898	0.948
0.2	1.05750	1.1	0.898	1.04
0.3	0.91300	1.125	0.894	0.918
0.5	0.70540	1.175	0.886	0.734
1.0	0.40900	1.3	0.867	0.461
2.0	0.20620	1.35	0.867	0.241
3.0	0.11312	1.4	0.867	0.137
4.0	0.07473	1.45	0.867	0.0940
5.0	0.04565	1.5	0.867	0.0594

**BASE GROUND MOTIONS**

Six recorded base ground motions were selected to represent the local seismic setting. We considered faulting mechanism, magnitude, and distance to recording station. Ground motions at the site are controlled by a crustal event and the CSZ interface event. We selected three acceleration time histories to represent each of these seismic sources as input for the seismic response analysis. Table C-3 provides the ground motions selected for this study.

**Table C-3. Selected Ground Motions**

Ground Motion/Year/Recording Station	Magnitude	Distance (km)	Component
<b>Crustal Records</b>			
Imperial Valley/El Centro Array #8	6.53	5.61	140
Loma Prieta/1989/Saratoga-Aloha Ave.	6.9	8.5	00
Cape Mendocino 1992/Cape Mendocino	7.01	6.96	00
<b>Subduction Zone Records</b>			
Valparaiso 1985/Pichilemu	7.8	80	90
Michoacan 1985/La Union	8.0	84	N00W
Michoacan 1985/Zihuatanejo	8.0	130	N90W

**SITE CONDITION MODELING**

We determined acceleration response spectra for the postulated scenarios discussed above by performing a site-specific seismic response analysis. An equivalent linear seismic response analysis as described in ASCE 7-10 Section 21.1.2. The site response analysis was performed using the SHAKE 91+ module of the EZ-FRISK 8.0 software package.

The input soil model used in our analysis is based on the findings of our subsurface exploration program. A detailed description of site subsurface conditions is provided in the main report. Shear wave velocities for the top approximately 50 feet of overburden soil were measured using a seismic CPT probe. Figure 2 shows the approximate location of the probe (CPT-1). Table C-4 provides a summary of the soil model used in our analysis. The acceleration response spectra produced by our equivalent linear seismic response analysis is presented on Figure C-3.

**Table C-4. Input Soil Profile**

<b>Depth Interval (feet BGS)</b>	<b>Subsurface Unit</b>	<b>Shear Wave Velocity (feet per second)</b>	<b>Modulus Reduction Curve</b>	<b>Damping Curve</b>
0 to 10	Medium stiff to Stiff Silt	800	Vucetic and Dobry, 1991	Vucetic and Dobry, 1991
10 to 20	Medium Stiff Clay	750	Vucetic and Dobry, 1991	Vucetic and Dobry, 1991
20 to 30	Medium Stiff Silt	750	Vucetic and Dobry, 1991	Vucetic and Dobry, 1991
30 to 70	Stiff to Very Stiff Clay	850	Vucetic and Dobry, 1991	Vucetic and Dobry, 1991
100 to 120 <sup>1</sup>	Very Dense Gravel	900 to 1,200	Gravel (Seed et al. 1986)	Gravel (Seed et al. 1986)

1. Input ground motion applied at base of this layer.

### **Near-Source Effects**

An empirical model of the response spectral amplitude ratio was developed by Somerville et al. (Somerville et al., 1997) to obtain a factor for adjusting the spectral acceleration. Based on this empirical model, the spectral acceleration factor is dependent on the building period and the directivity function, which is based on the dip of the fault. The Somerville et al. graph shows that the near-surface effects are negligible for periods less than 0.6 second for a strike-slip fault such as the Portland Hills and Oatfield faults, which are mapped within 5 km from the site. Since we anticipate the proposed one- to two-story school building will likely have a period no greater than 0.5 second, we anticipate the near-source effects on the site due to the significant faults within 5 km of the site should be negligible.

### ***DETERMINISTIC MCE<sub>r</sub> RESPONSE SPECTRUM***

The deterministic approach considers the maximum ground acceleration that may occur at the site as a result of a characteristic earthquake on all known active faults in the region. ASCE 7-10 Section 21.2.2 requires that the spectral response at each period be calculated as an 84<sup>th</sup> percentile 5 percent damped spectral response acceleration in the direction of maximum horizontal response. However, the lower limit is computed in accordance with Figure 21.2-1 in ASCE 7-10, where  $F_a$  and  $F_v$  are determined using Tables 11.4-1 and 11.4-2 in ASCE 7-10. Figure C-4 shows the deterministic lower limit as prescribed by ASCE 7-10 Section 21.2.2.

### ***SITE-SPECIFIC MCE<sub>R</sub> RESPONSE SPECTRUM***

As outlined in ASCE 7-10 Section 21.2.3, the site-specific MCE<sub>R</sub> shall be taken as the lesser of the probabilistic MCE<sub>R</sub> and the deterministic MCE<sub>R</sub>. Figure C-4 shows the site-specific design response spectrum.

### ***DESIGN RESPONSE SPECTRUM***

ASCE 7-10 Section 21.3 states that the site-specific MCE<sub>R</sub> response spectrum is reduced to two-thirds of the acceleration at any period. However, the lower bound for design ground motions is 80 percent of the generalized response spectrum as outlined in ASCE 7-10 Section 11.4.5.

### ***DESIGN ACCELERATION PARAMETERS***

To develop the final design response spectrum, the lesser of the values obtained from the probabilistic MCE and the deterministic MCE are taken at each period. The parameter  $S_{DS}$  is taken from the site-specific response spectrum at a period of 0.2 second but shall not be smaller than 90 percent of the peak spectral acceleration taken at any period larger than 0.2 second. The parameter  $S_{D1}$  is taken as the greater of the spectral acceleration at 1 second or two times the acceleration at 2 seconds. Figure C-5 shows the design response spectrum.

## **GEOLOGIC HAZARDS**

In addition to ground shaking, site-specific geologic conditions can influence the potential for earthquake damage. Deep deposits of loose or soft alluvium can amplify ground motions, resulting in increased seismic loads on structures. Other geologic hazards are related to soil failure and permanent ground deformation. Permanent ground deformation could result from liquefaction, lateral spreading, landsliding, and fault rupture. The following sections provide additional discussion regarding potential seismic hazards that could affect the proposed development.

### ***FAULT SURFACE RUPTURE***

Information on faulting in the region and site area is available from Madin (1990; GFR 90-2); Geomatrix (1995); and Wong, et al. (2000; IM516). This information indicates that the Oatfield fault is located approximately 1.5 miles east of the site. Due to the lack of evidence for recent activity of the fault, the distance of the fault from the site, and since no quaternary faults are mapped directly beneath the site, it is our opinion that the probability of fault rupture beneath the site is low.

### ***LIQUEFACTION***

Liquefaction is caused by a rapid increase in pore water pressure that reduces the effective stress between soil particles to near zero. Granular soil, which relies on interparticle friction for strength, is susceptible to liquefaction until the excess pore pressures can dissipate. In general, loose, saturated sand soil with low silt and clay content is the most susceptible to liquefaction. Silty soil with low plasticity is moderately susceptible to liquefaction under relatively higher levels of ground shaking. The soil encountered during our subsurface exploration is not susceptible to liquefaction under design levels of ground shaking.

### ***LATERAL SPREAD***

Lateral spread is a liquefaction-related seismic hazard. Development areas subject to lateral spreading are typically gently sloping or flat sites underlain by liquefiable sediments adjacent to an open face, such as riverbanks. Liquefied soil adjacent to open faces may “flow” in that direction, resulting in surface cracking and lateral displacement towards the open face (i.e., riverbank). The magnitude of lateral spread decreases with distance from the open face. Lateral spreading is evaluated using procedures first developed by Bartlett and Youd and published in 1992. Based on the relatively low groundwater table and low susceptibility of the site to liquefaction, lateral spreading is expected to be negligible at this site.

### ***GROUND MOTION AMPLIFICATION***

Soil capable of significantly amplifying ground motions beyond the levels determined by our site-specific seismic response analysis was not encountered during our subsurface investigation program. The main report provides a detailed description of the subsurface conditions encountered. We conclude the level of amplification determined by our response analysis is appropriate and the facility can be designed using the levels of ground shaking prescribed by the IBC.

### ***LANDSLIDE***

Earthquake-induced landsliding generally occurs in steeper slopes comprised of relatively weak soil deposits. The site primarily contains relatively gently sloping terrain, and based on our findings in our study of the existing stream bank slopes at the south boundary of the property, we anticipate landslides do not present a risk within the proposed development areas of the site.

### ***SETTLEMENT***

Settlement due to earthquakes is most prevalent in relatively deep deposits of dry, clean sand. We do not anticipate that significant settlement in addition to liquefaction-induced settlement will occur during design levels of ground shaking.

### ***SUBSIDENCE/UPLIFT***

Subduction zone earthquakes can cause vertical tectonic movements. The movements reflect coseismic strain release accumulation associated with interplate coupling in the subduction zone. Based on our review of the literature, the locked zone of the CSZ is located in excess of 60 miles from the site. Consequently, we do not anticipate that subsidence or uplift is a significant design concern.

### ***LURCHING***

Lurching is a phenomenon generally associated with very high levels of ground shaking, which cause localized failures and distortion of the soil. The anticipated ground accelerations shown on Figure C-3 are below the threshold required to induce lurching of the site soil.

### ***SEICHE AND TSUNAMI***

The site is inland and elevated away from tsunami inundation zones and away from large bodies of water that may develop seiches. Seiches and tsunamis are not considered a hazard in the site vicinity.

## LIMITATIONS

We have prepared this seismic hazard study for use by the design and construction team for the proposed Kaiser K5 school. The conclusions presented in this report are based on the data available at the time this report was written.

Our seismic hazard study report, conclusions, and interpretations should not be construed as a warranty of subsurface conditions and earthquake ground motions. We have interpreted subsurface conditions based on our exploration and review of available geologic information. The design earthquakes and base rock accelerations referred to are based on review of available data, literature, and our previous experience.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with the generally accepted practices in this area at the time the report was prepared. No warranty or other conditions, express or implied, should be understood.

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State of Oregon 2014 Structural Specialty Code

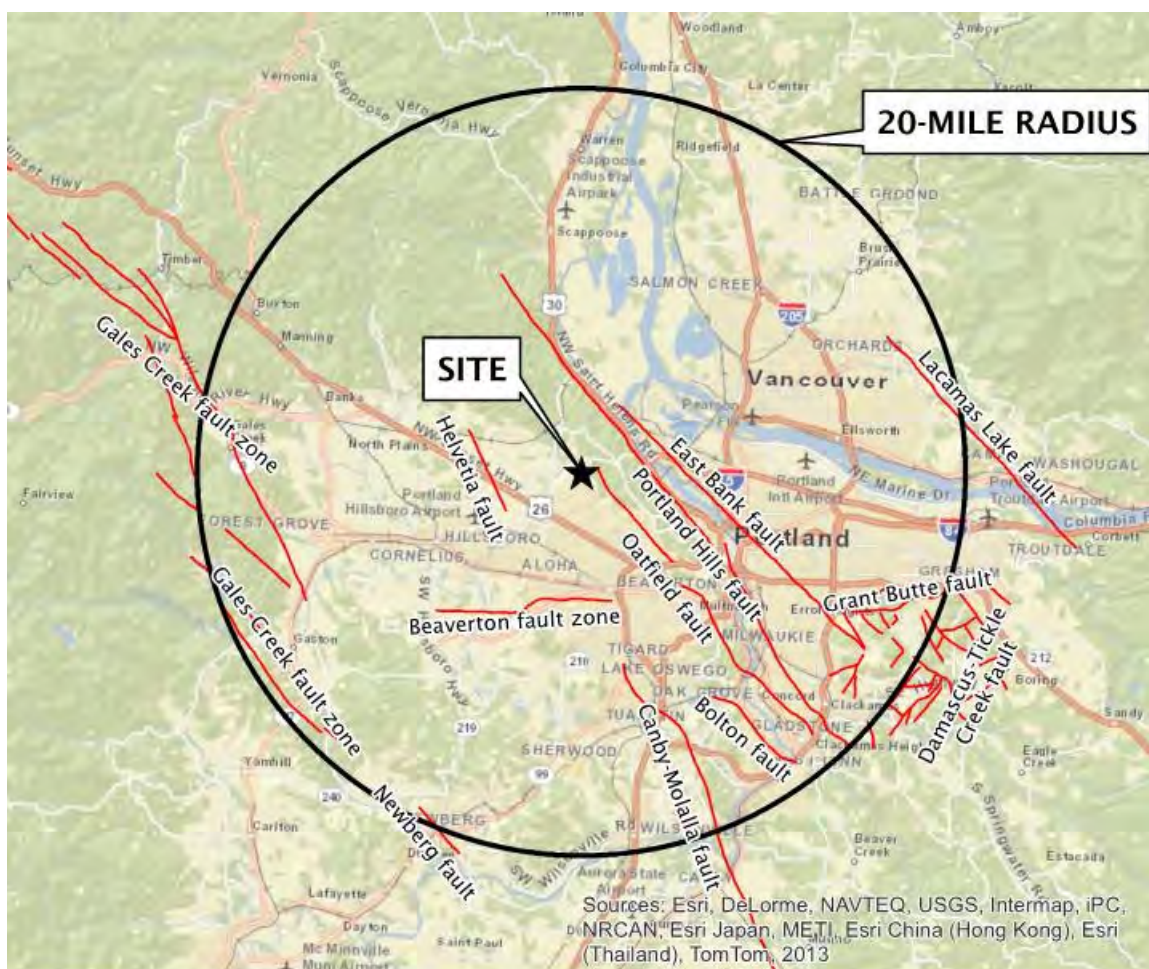
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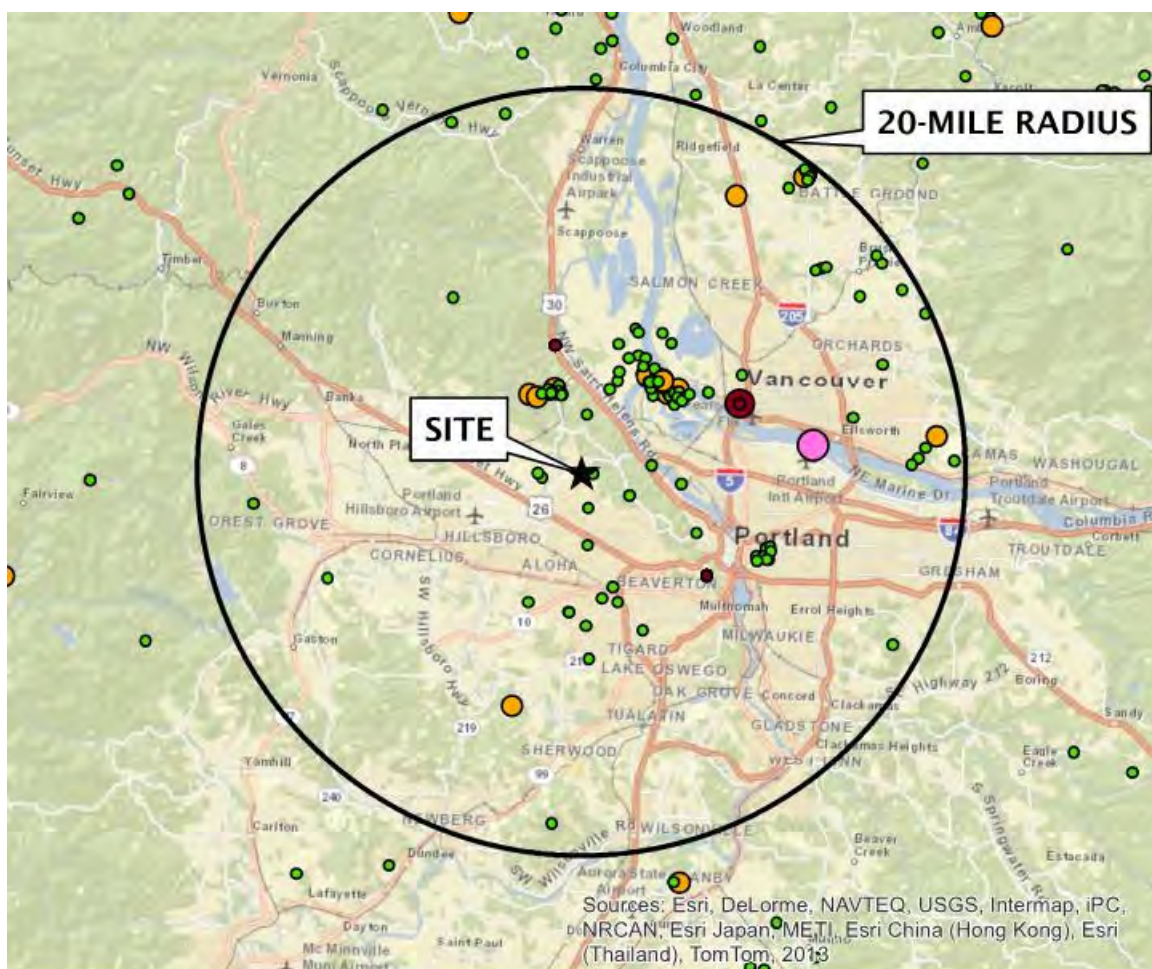
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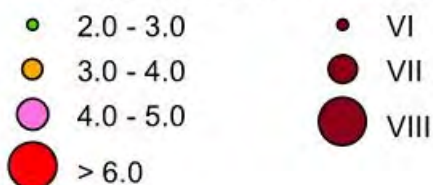
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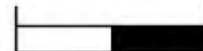


## LEGEND

### EARTHQUAKE MAG MAXIMUM MODIFIED MERCALLI INTENSITY (MMI)



0 5 10



(SCALE IN MILES)

HISTORICAL MMI DATA FROM NGDG (2010)

INSTRUMENTAL MAGNITUDE FROM USGS (2009), PNSN (2015)

**GEODESIGN INC**

15575 SW Sequoia Parkway · Suite 100  
Portland OR 97224  
Off 503.968.8787 Fax 503.968.3068

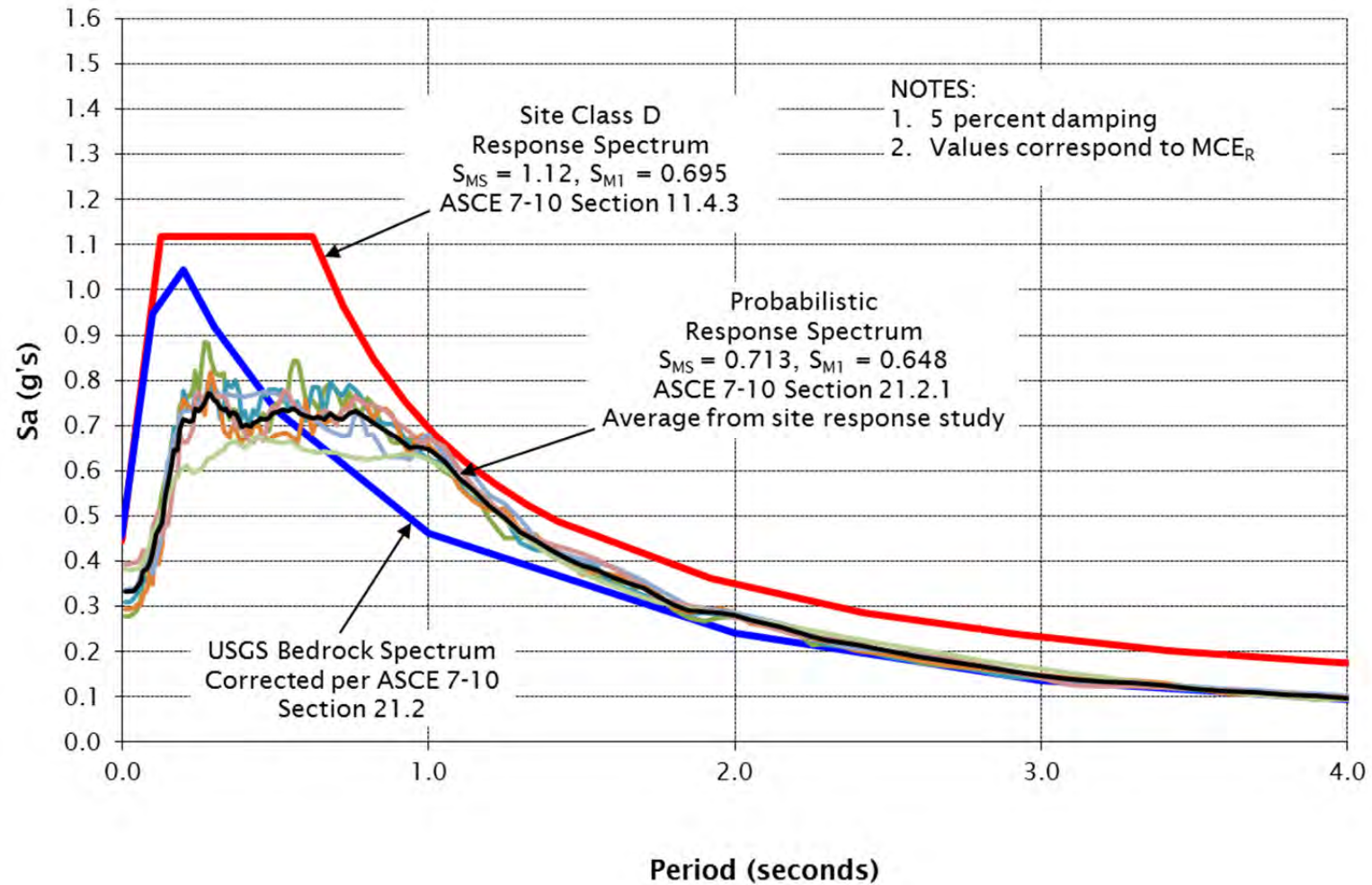
BEAVSCHOOL-49-01

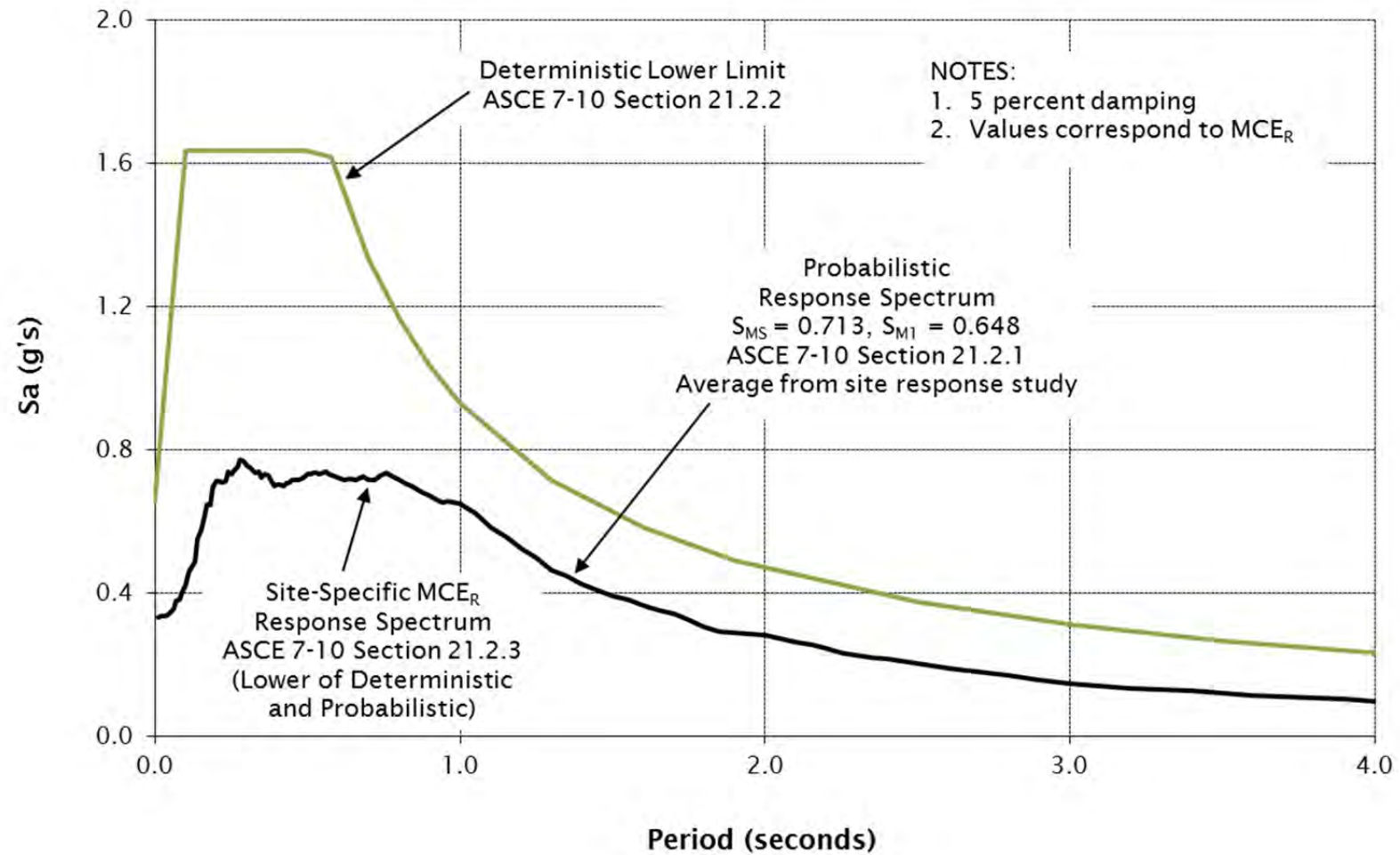
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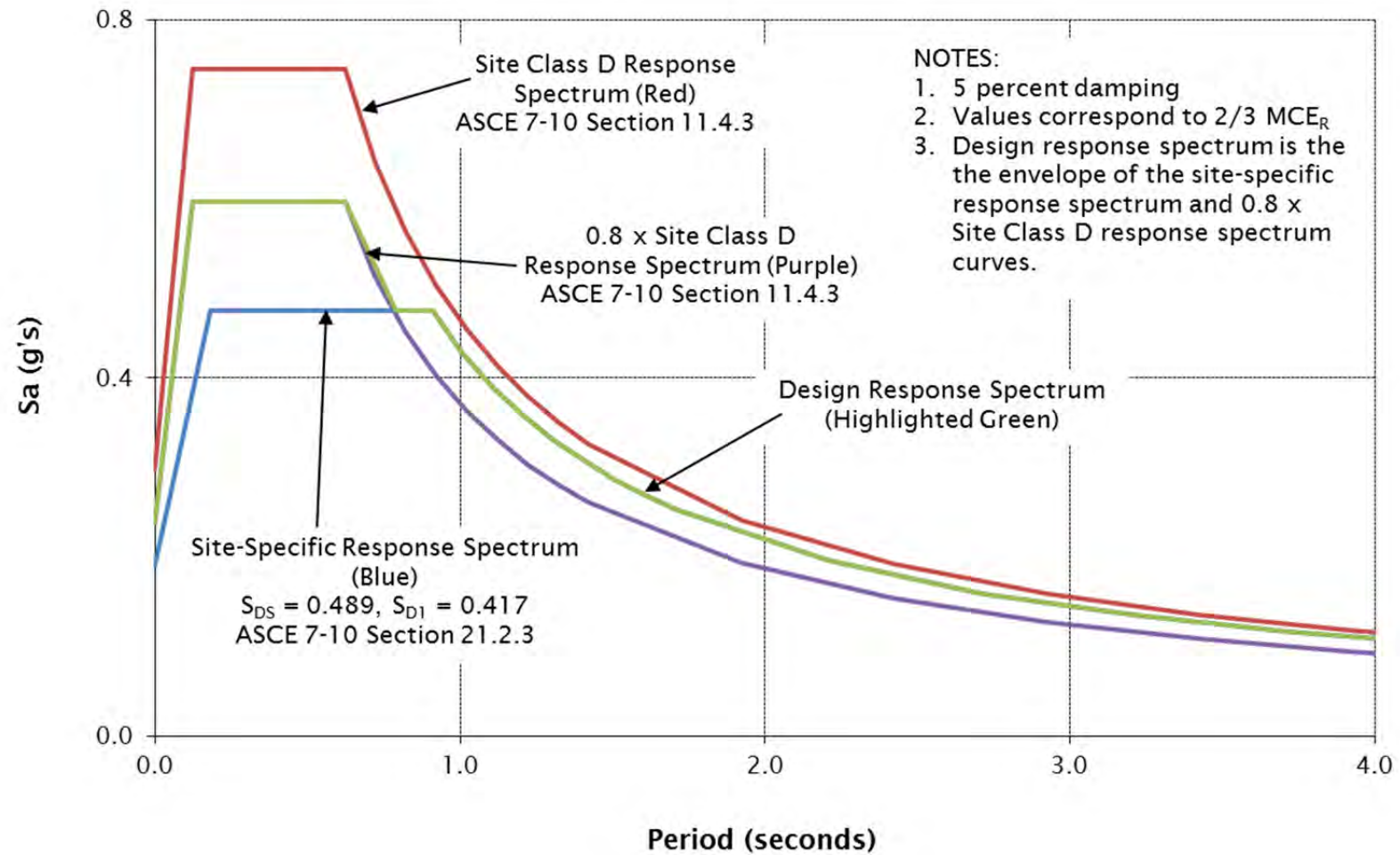
## HISTORICAL SEISMICITY MAP

KAISER K5  
WASHINGTON COUNTY, OR

**FIGURE C-2**



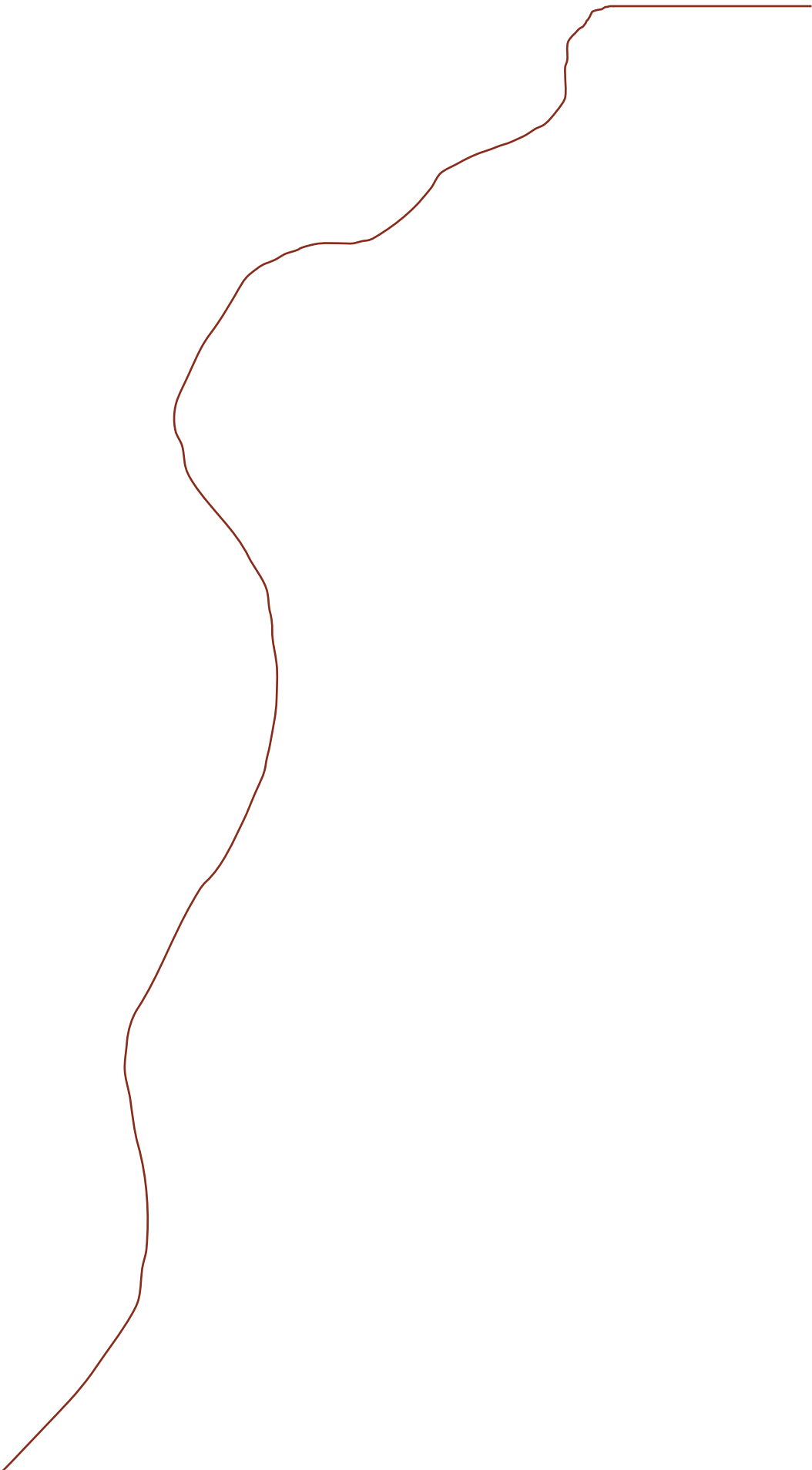




## ACRONYMS

## ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
AC	asphalt concrete
ACP	asphalt concrete pavement
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
BGS	below ground surface
BSD	Beaverton School District
CPT	cone penetrometer test
CRBG	Columbia River Basalt Group
CSZ	Cascadia Subduction Zone
DEM	digital elevation model
ESAL	equivalent single-axle load
g	gravitational acceleration (32.2 feet/second <sup>2</sup> )
H:V	horizontal to vertical
IBC	International Building Code
km	kilometers
LiDAR	light detection and ranging
MCE	maximum considered earthquake
MCE <sub>R</sub>	risk-targeted maximum considered earthquake
MSL	mean sea level
OSHA	Occupational Safety and Health Administration
OSSC	Oregon Standard Specifications for Construction (2015)
OWRD	Oregon Water Resources Department
PCC	portland cement concrete
pcf	pounds per cubic foot
PG	performance grade
PGA	peak ground acceleration
psf	pounds per square foot
psi	pounds per square inch
SOSSC	State of Oregon Structural Specialty Code
SPT	standard penetration test
USGS	U.S. Geological Survey



To:	Jessica Faust	From:	Viola Lai
Company:	Beaverton School District Facilities Development Department	Date:	December 17, 2015
Address:	16550 SW Merlo Road Beaverton, OR 97003		

cc:	Monte Higbee, WHPacific, Inc. (via email only) Eric Bolken, DLR Group (via email only) Aaron Olson, Cameron McCarthy (via email only)
-----	---

GDI Project:	BeavSchool-49-01
RE:	Kaiser K5

Original File Name	Date	Document Title
BeavSchool-49-01-121415-geor	12/14/15	Report of Geotechnical Engineering Services; Kaiser K5; 7775 NW Kaiser Road; Washington County, Oregon

Addendum Number	Date	Description
1	12/17/15	Vegetated Stream Corridor (attached)

kt

Attachment

One copy submitted (via email only)

Document ID: BeavSchool-49-01-121715-geoat-1.docx

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To:	Jessica Faust	From:	Viola C. Lai, P.E., G.E. and George Saunders, P.E., G.E.
Company:	Beaverton School District Facilities Development Department	Date:	December 17, 2015
Address:	16550 SW Merlo Road Beaverton, OR 97003		
cc:	Monte Higbee, WHPacific, Inc. (via email only) Eric Bolken, DLR Group (via email only) Aaron Olson, Cameron McCarthy (via email only)		
GDI Project:	BeavSchool-49-01		
RE:	Addendum 1 Vegetated Stream Corridor Kaiser K5 7775 NW Kaiser Road Washington County, Oregon		

This addendum provides our further clarification regarding the slope stability associated with the vegetated stream corridor for the proposed Kaiser K5 school located at 7775 NW Kaiser Road in Washington County, Oregon.

We have reviewed Sheets 1 through 3 provided by WHPacific that show the vegetated stream corridor at the south boundary of the site. These plans are presented in the Attachment of this addendum. The vegetated corridor is shown in green on Sheets 2 and 3. As discussed in the “Background” and “Surface Conditions” sections of our geotechnical report<sup>1</sup>, we concluded that the stream embankments (within the vegetated corridor) are stable based on our field reconnaissance and review of our previous study of the slopes of the site. In our opinion, the existing slopes above the vegetated corridor, to the north and northeast of the vegetated corridor boundary, are also adequately stable. At the time of our geotechnical report, the proposed improvement located closest to the vegetated stream corridor was a retaining wall at the south end of the site, approximately 40 feet from the vegetated stream corridor boundary. As discussed in the “Permanent Slopes” section of our report, our analysis indicated that the retaining wall is set back far enough from the vegetated stream corridor and should not affect overall slope stability.

◆ ◆ ◆

<sup>1</sup> GeoDesign, Inc., 2015. *Report of Geotechnical Engineering Services; Kaiser K5; 7775 NW Kaiser Road; Washington County, Oregon*, dated December 14, 2015. GeoDesign Project: BeavSchool-49-01

We hope this information meets your needs at this time. Please call if we can provide additional information.

VCL:GPS:kt

Attachment

One copy submitted (via email only)

Document ID: BeavSchool-49-01-121715-geoa-1.docx

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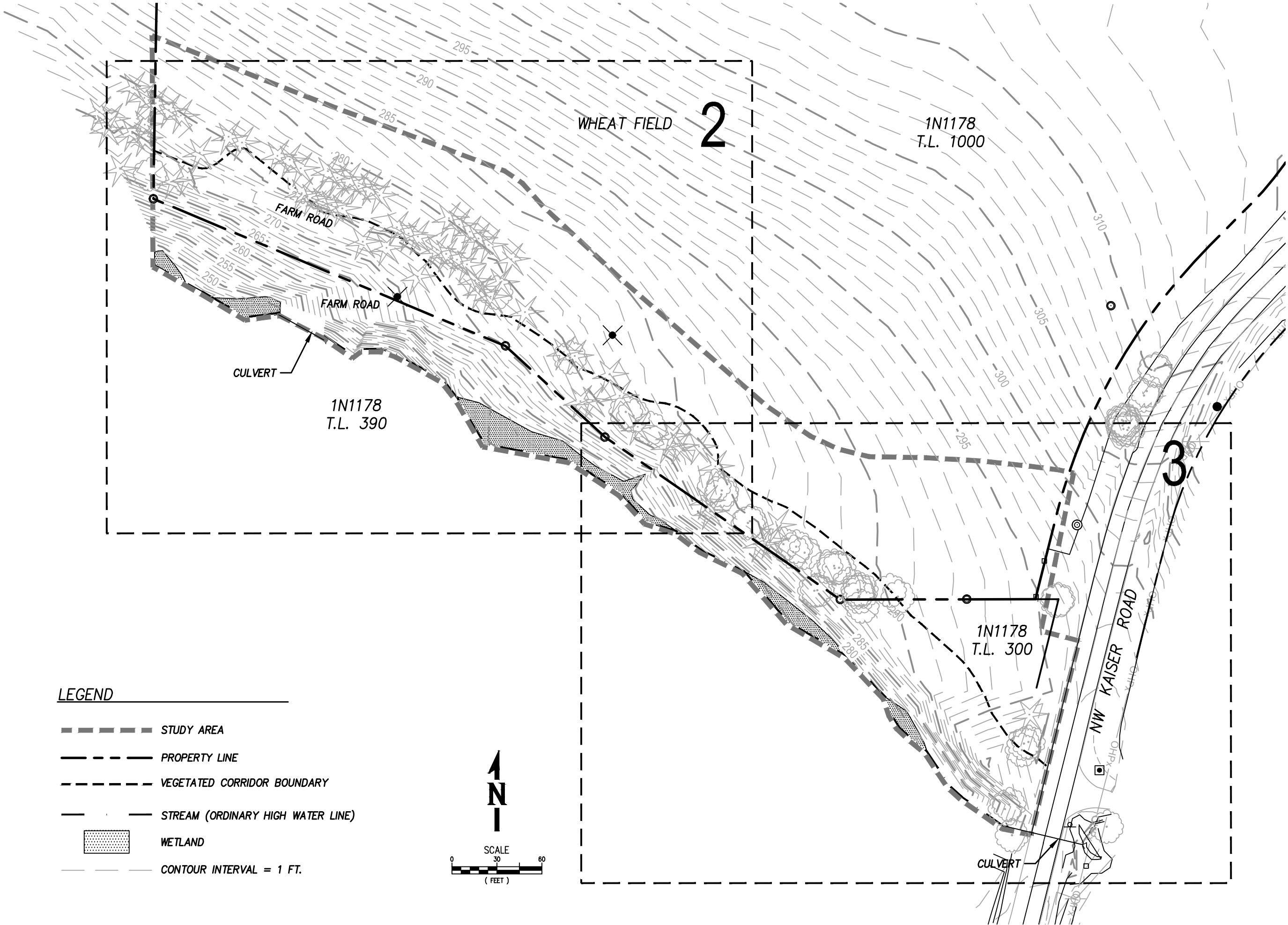
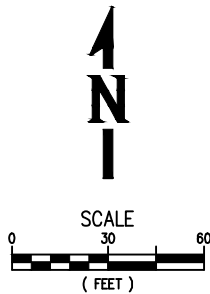


**ATTACHMENT**

[DATE: 11/23/2015 12:36 PM ] [AUTHOR: jmaynard] [PLOTTER: DWG To PDF.pc3] [STYLE: whp-Standard.ctb]  
[PATH: P:\Beaverton School District\0008357W\Environmental\Exhibits\0008357W-C-WT01.dwg ] [LAYOUT: 1 FIGURE 3 - VEGETATED CORRIDOR ]

LEGEND

- STUDY AREA
- PROPERTY LINE
- VEGETATED CORRIDOR BOUNDARY
- STREAM (ORDINARY HIGH WATER LINE)
- WETLAND
- CONTOUR INTERVAL = 1 FT.



WHPacific

9755 SW Barnes Rd, Suite 300  
Portland, OR 97225  
503-526-0455 Fax 503-526-0775  
www.whpacific.com

PRELIM

REVISIONS			
NO.	BY	DATE	REMARKS

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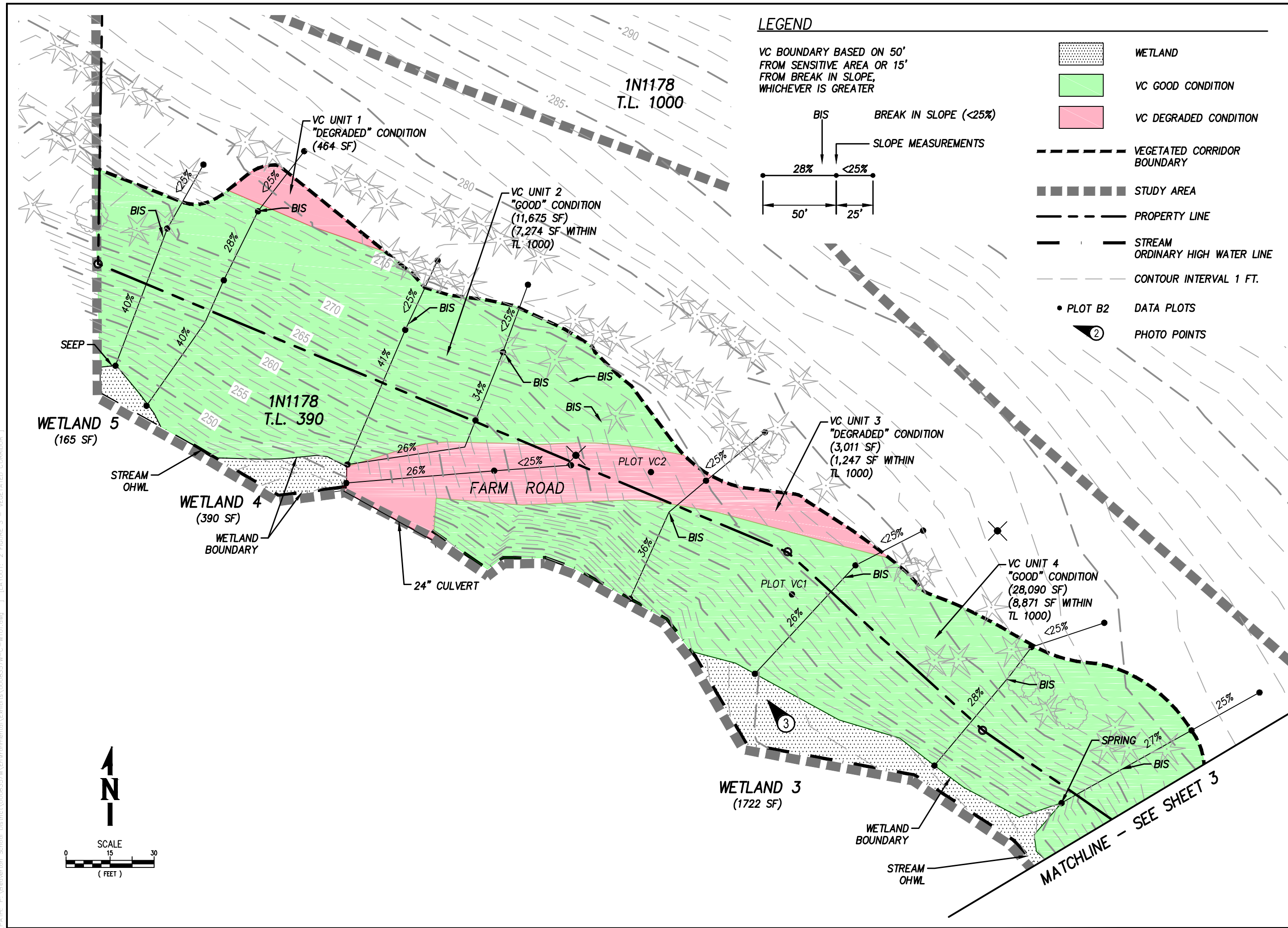
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[DATE: 11/23/2015 12:36 PM] [AUTHOR: jmaynard] [PLOTTER: DWG To PDF.pc3] [STYLE: whp-Standard.ctb]  
[PATH: P:\Beaverton School District\0008357W\Environmental\Exhibits\0008357W-C-WT01.dwg] [LAYOUT: 2 FIGURE 3 - VEGETATED CORRIDOR]



**WHPacific**  
9755 SW Barnes Rd, Suite 300  
Portland, OR 97225  
503-626-0450 Fax 503-626-0775  
www.whpacific.com

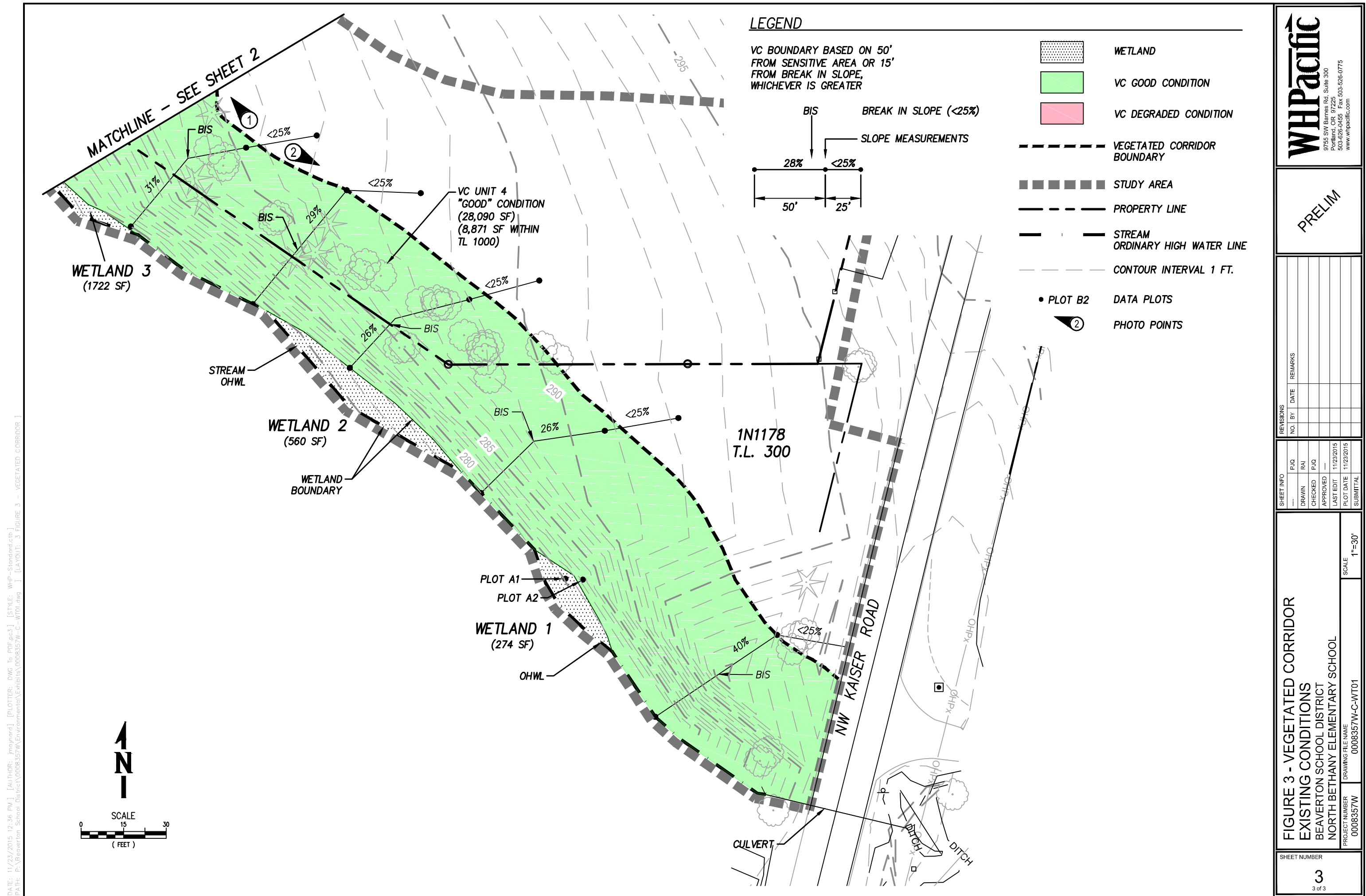
**PRELIM**

REVISIONS	
NO.	DATE

SHEET INFO	
NO.	DATE

FIGURE 3 - VEGETATED CORRIDOR EXISTING CONDITIONS	
BEAVERTON SCHOOL DISTRICT	
NORTH BETHANY ELEMENTARY SCHOOL	
PROJECT NUMBER	DRAWING FILE NAME
0008357W	0008357W-C-WT01

SHEET NUMBER	
2	
2 of 3	



To:	Jessica Faust	From:	Viola Lai
Company:	Beaverton School District Facilities Development Department	Date:	January 12, 2016
Address:	16550 SW Merlo Road Beaverton, OR 97003		

cc:	Monte Higbee, WHPacific, Inc. (via email only) Eric Bolken, DLR Group (via email only) Aaron Olson, Cameron McCarthy (via email only)
-----	---

GDI Project:	BeavSchool-49-01
RE:	Kaiser K5

Original File Name	Date	Document Title
BeavSchool-49-01-121415-geor	12/14/15	Report of Geotechnical Engineering Services; Kaiser K5; 7775 NW Kaiser Road; Washington County, Oregon

Addendum Number	Date	Description
1	12/17/15	Vegetated Stream Corridor
2	1/12/16	Clarification of Site Slope Stability (attached)

kt

Attachment

One copy submitted (via email only)

Document ID: BeavSchool-49-01-011216-geoat-2.docx

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To:	Jessica Faust	From:	Viola C. Lai, P.E., G.E., Erick J. Staley, C.E.G., and George Saunders, P.E., G.E.
Company:	Beaverton School District Facilities Development Department	Date:	January 12, 2016
Address:	16550 SW Merlo Road Beaverton, OR 97003		
cc:	Monte Higbee, WHPacific, Inc. (via email only) Eric Bolken, DLR Group (via email only) Aaron Olson, Cameron McCarthy (via email only)		
GDI Project:	BeavSchool-49-01		
RE:	Addendum 2 Clarification of Site Slope Stability Kaiser K5 7775 NW Kaiser Road Washington County, Oregon		

## INTRODUCTION

This addendum (Addendum 2) provides additional discussion on the site slope stability consideration associated with the proposed Kaiser K5 school to be located at 7775 NW Kaiser Road in Washington County, Oregon. We previously prepared a December 14, 2015 geotechnical report<sup>1</sup> and a December 17, 2015 addendum<sup>2</sup> (Addendum 1) for the site. Our geotechnical report addresses slope stability of the site, includes the findings from our prior geological evaluation of the site slopes, and concludes that the site prior to and following development is not susceptible to slope instability. Addendum 1 provided a discussion on the slope stability specific to the vegetated stream corridor in response to questions from Clean Water Services (CWS).

The geotechnical report and Addendum 1 were submitted to Washington County (County), which resulted in an incompleteness notice from the County relative to CDC Section 410-4.1 D. Email correspondence between Kofi Nelson-Owusu of the County and other members of the team resulted in a January 11, 2016 email from Mr. Nelson-Owusu indicating that the combination of the December 14, 2015 geotechnical report, the December 17, 2015 addendum, and the email correspondence “appears to have met CDC Section 410-4.1 D provisions” and requested that

<sup>1</sup> GeoDesign, Inc., 2015. *Report of Geotechnical Engineering Services; Kaiser K5; 7775 NW Kaiser Road; Washington County, Oregon*, dated December 14, 2015. GeoDesign Project: BeavSchool-49-01

<sup>2</sup> GeoDesign, Inc., 2015. *Addendum 1; Vegetated Stream Corridor; Kaiser K5; 7775 NW Kaiser Road; Washington County, Oregon*, dated December 17, 2015. GeoDesign Project: BeavSchool-49-01

stamped and signed correspondence be provided. The following sections provide our response and have been framed relative to the requirements of CDC Section 410-4.1 D.

## CDC SECTION 410-4.1 D

**410-4.1D. The engineering geology report prepared in accordance to Section 410-4.1 B. shall:**  
**(1) Address any potential geological hazard associated with grading on steep slopes and the proposed development and recommend measures intended to mitigate potential hazards;**

Refer to the geotechnical report with special focus on the vegetated stream corridor in Addendum 1. We completed a slope stability analysis of a representative section (cross section A-A') of the site. A site plan showing cross section A-A' and results of the stability analysis are presented in Attachment A. Some grading will occur on the upland terrace of the site, where the ground surface is gradually sloped, with slopes no steeper than 25 percent. The proposed grading and improvements are set back at least 40 feet from the north boundary of the vegetated stream corridor. Grading is not proposed within the vegetated stream corridor boundary or on any slopes greater than 25 percent. As discussed in our geotechnical report and Addendum 1, and based on our slope stability analysis (Attachment A), it is our opinion that there are no geological hazards (slope stability issues) associated with the proposed grading plan.

We have included an excerpt of our December 14, 2015 geotechnical report below:

### **1.2 BACKGROUND**

*We previously completed a slope evaluation (GeoDesign, 2010) of this site in 2010, as part of a larger study that included a total of 75 acres. Our study included a site-specific reconnaissance of the slopes at the south boundary of this site, which were broadly classified as moderately susceptible to landslides in landslide susceptibility maps (Burns and Mickelson, 2009). Our study included reviewing geologic maps, soil mapping with the National Research Conservation Service, evaluation of the LiDAR DEM covering the site vicinity, and a field reconnaissance of the slopes on site. Based on our review and field reconnaissance, we concluded that slopes shallower than 50 percent are stable and do not have a significant susceptibility for shallow-seated landsliding. Although dense vegetation prevented close observation of the steeper slopes at the site, and it is possible that incised stream banks where the slope exceeds 50 percent could be potentially unstable, the slope gradient map shows that the slopes exceeding 50 percent are mainly located along the heads of the incised stream drainage to the west of the proposed school property boundary. In addition, given these incised stream drainages generally reach heights of only 10 to 15 feet, our report concluded that it was likely that riparian buffers required around the stream drainages crossing the site will provide sufficient setback to mitigate any slope stability concerns. Our report also concluded that deep-seated landsliding is not likely at the [proposed school] site. We did not observe any evidence of recent deep-seated landsliding during our field reconnaissance, such as steep head or internal scarps or back-rotated trees.*

### 3.2 SURFACE CONDITIONS

*The site is situated on agricultural farmland consisting predominantly of plowed fields with rows of tall grass. The site is bordered along the eastern perimeter by NW Kaiser Road and on the south perimeter by a moderately steep slope down towards a small stream. The stream corridor consists of trees and brush. The agricultural land extends beyond the west boundary of the proposed development area. A residential dwelling exists on the northeast portion of the development area, adjacent to NW Kaiser Road. The site slopes gently to moderately downward from northeast to southwest with elevations varying between approximately 312 feet above MSL on the northeastern perimeter to 290 feet above MSL along the southern perimeter of the proposed development area.*

*We conducted a geological reconnaissance of the stream embankment area at the south boundary of the site. The stream slopes were heavily vegetated with blackberry brush and trees. We did not observe any visible signs of slope instability such as bent tree trunks or sloughing or cracking at the top of the embankments. There was a footpath that extended through the brush partway up the embankment. In addition, a roadway extends in the east-west direction on the north side of the stream bank. Generally, our observations were in agreement with those documented in our previous study and described in the "Background" section of this report.*

### 6.3 PERMANENT SLOPES

*Permanent cut and fill slopes should not exceed 2H:1V. Slopes to be maintained by mowing should not exceed 3H:1V. Access roads and pavements should be located at least 5 feet from the top of cut and fill slopes. The setback for buildings should be increased to 10 feet from top of cut and fill slopes. The current plan shows the southernmost retaining wall located approximately 40 feet from the stream buffer zone at the closest point. The buffer zone is an additional 20 feet from the top of the stream bank. Based on our analysis, this provides adequate setback for overall slope stability. The slopes should be planted with appropriate vegetation to provide protection against erosion as soon as possible after grading. Surface water runoff should be collected and directed away from slopes to prevent water from running down the face of the slope.*

The December 17, 2015 addendum report further evaluated slope stability specific to the vegetated corridor.

*This addendum provides our further clarification regarding the slope stability associated with the vegetated stream corridor for the proposed Kaiser K5 school located at 7775 NW Kaiser Road in Washington County, Oregon.*

*We have reviewed Sheets 1 through 3 provided by WHPacific that show the vegetated stream corridor at the south boundary of the site. . . . The vegetated corridor is shown in green on Sheets 2 and 3. As discussed in the "Background" and "Surface Conditions" sections of our geotechnical report, we concluded that the stream embankments (within the vegetated*

*corridor) are stable based on our field reconnaissance and review of our previous study of the slopes of the site. In our opinion, the existing slopes above the vegetated corridor, to the north and northeast of the vegetated corridor boundary, are also adequately stable. At the time of our geotechnical report, the proposed improvement located closest to the vegetated stream corridor was a retaining wall at the south end of the site, approximately 40 feet from the vegetated stream corridor boundary. As discussed in the "Permanent Slopes" section of our report, our analysis indicated that the retaining wall is set back far enough from the vegetated stream corridor and should not affect overall slope stability.*

***(2) Address any potential landslide hazards associated with grading on land and developing land determined to be susceptible to either shallow- or deep-seated landslides and recommend measures intended to mitigate potential landslide hazards;***

As discussed in our geotechnical report and Addendum 1, and based on our slope stability analysis, it is our opinion that the site is not susceptible to shallow- and deep-seated landslides associated with the proposed grading plan and development. Refer to our discussions for item (1) above. The proposed grading and development is generally limited to the upland terrace areas at least 40 feet north of the vegetated stream corridor boundary. Moreover, grading is limited to areas with slopes less than 25 percent. Grading will not occur in areas steeper than 25 percent.

***(3) Contain a detailed description of the study area's (as defined in Section 410-4.1) geology and include findings regarding the effect of the geologic conditions on the proposed development;***

These descriptions and findings are included in our geotechnical report and Addendum 1 for the site.

***(4) When applicable, provide findings regarding the effect of the geologic conditions on the susceptibility of both shallow- and deep-seated landslides; and***

Refer to the geotechnical report with special focus on the vegetated stream corridor in Addendum 1. Our conclusion is that there is no slope stability issue with the proposed grading plan provided the graded slopes and retaining walls are constructed in accordance with our geotechnical recommendations.

***(5) Address proposed stormwater management approach.***

WHPacific's summary of the proposed stormwater management approach is provided below as well as the drawing depicting the details of the design in Attachment B. The stormwater management plan does not represent a geotechnical engineering concern.

*The stormwater runoff from all new impervious areas that are part of this project will be collected and piped to a water quality facility. The majority of the water quality [facility] is*

*located along the north and northeast portions of the site and will consist of "Low Impact Development Approaches" (LIDA) or water quality storm filters (acceptable per CWS standards). After water quality treatment, the stormwater will be conveyed along the west side of the property or in Kaiser Road, and will discharge in the existing stream. Clean Water Services is currently working on design for regional facilities, that will handle stormwater quantity, therefore none is planned onsite.*

◆ ◆ ◆

We hope this information meets your needs at this time. Please call if we can provide additional information.

VCL:EJS:GPS:kt

Attachments

One copy submitted (via email only)

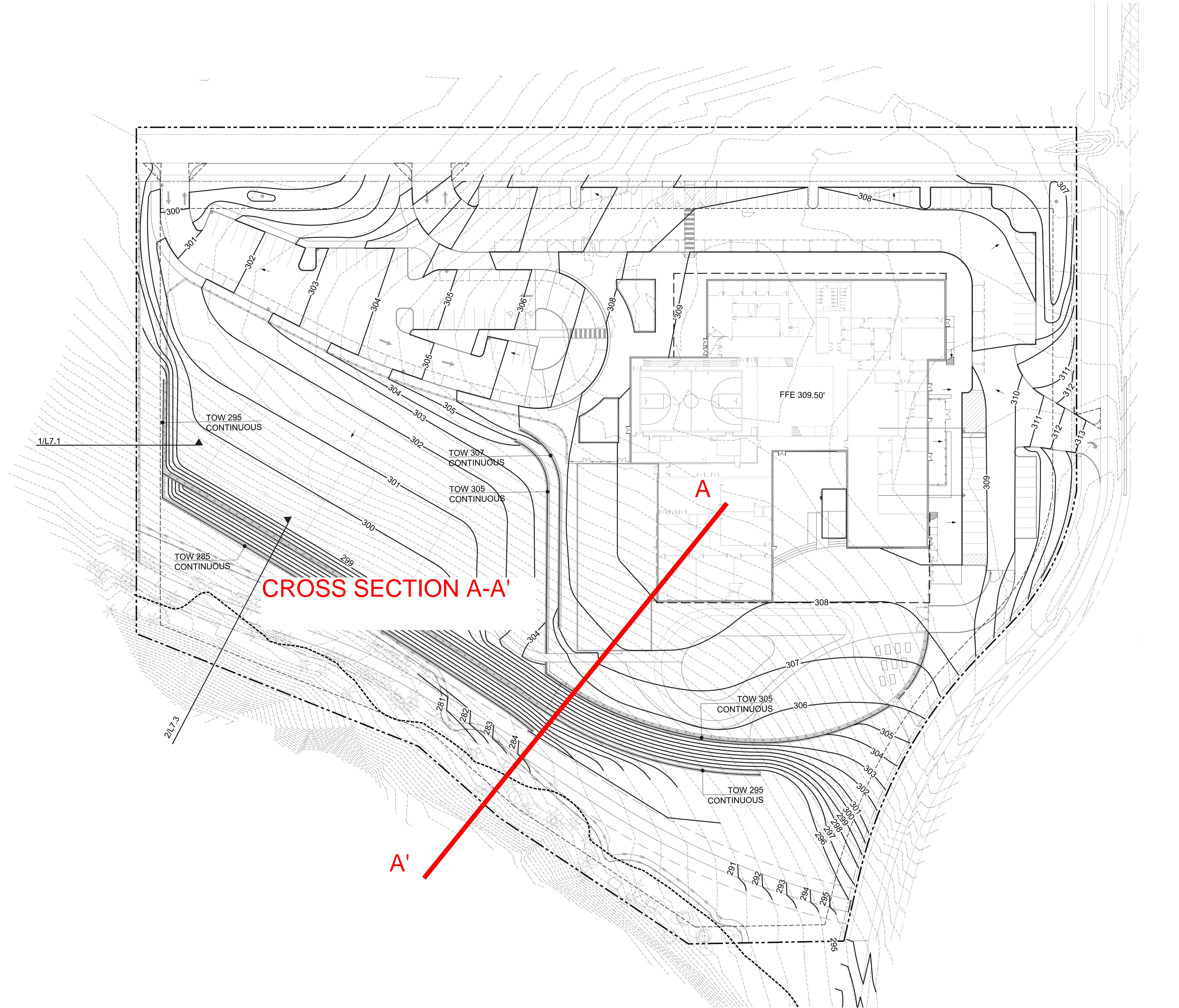
Document ID: BeavSchool-49-01-011216-geoa-2.docx

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**ATTACHMENT A**

# GRADING PLAN



## SHEET NOTES

1. ALL SURVEY INFORMATION PROVIDED BY:  
WH PACIFIC  
9755 SW BARNES ROAD, SUITE 300  
PORTLAND, OR 97225
2. ALL ACCESSIBLE COMPONENTS INCLUDING, BUT NOT LIMITED TO, SIGNS, RAMPS, TACTILE WARNINGS, MARKINGS, ETC. SHALL CONFORM TO OREGON STATE STANDARDS FOR PARKING AND ACCESS FOR THE DISABLED.
3. VERIFY EXACT LOCATIONS AND ROUTING OF EXISTING UNDERGROUND UTILITIES PRIOR TO STARTING EXCAVATION. REPAIR ANY DAMAGE TO EXISTING PIPES, UTILITIES OR RELATED FACILITIES AT CONTRACTOR'S EXPENSE IN A MANNER APPROVED BY OWNER'S REPRESENTATIVE.
4. BARRICADE AND PROTECT TRUNKS, LIMBS, ROOTS AND ROOT ZONES BEYOND DRIPLINE OF EXISTING TREES AND PLANT MATERIALS TO REMAIN AS DIRECTED BY OWNER'S REPRESENTATIVE. CUT NO LIMBS OR ROOTS LARGER THAN 2" IN DIAMETER WITHOUT APPROVAL OF OWNER'S REPRESENTATIVE. NOTIFY OWNER'S REPRESENTATIVE PRIOR TO PERFORMING ANY EXCAVATION WITHIN PROTECTION AREAS.
5. CONTOURS SHOWN ON KAISER ROAD AND P-14 SHOWN FOR REFERENCE ONLY. FINAL ENGINEERING AND ROAD DESIGN TO BE PROVIDED BY CIVIL ENGINEER.
6. ALL GRADING EFFORTS WILL COMPLY WITH CDC 410-1.1 AND 410-1.2

## LEGEND

- PROPERTY LINE
- - - SETBACK
- ☼ EXISTING TREES TO REMAIN
- XXX.XX SPOT GRADE
- FFE FINISH FLOOR ELEVATION
- NEW CONTOUR (1' INTERVAL)
- - - EXISTING CONTOUR (1' INTERVAL)
- ↗ BREAK IN PLANE  
ARROW INDICATES DIRECTION OF FLOW
- TOW TOP OF WALL ELEVATION

Land Use

GRADING PLAN  
Kaiser K5  
Beaverton School District

L4.0

74-15111-20  
10/19/2015  
REVISIONS  
CAMERON  
McCARTHY  
LANDSCAPE ARCHITECTURE & PLANNING  
1000 NE Oregon Street, Suite 200  
Portland, OR 97232  
www.cameronmccarthy.com • 503.466.4838

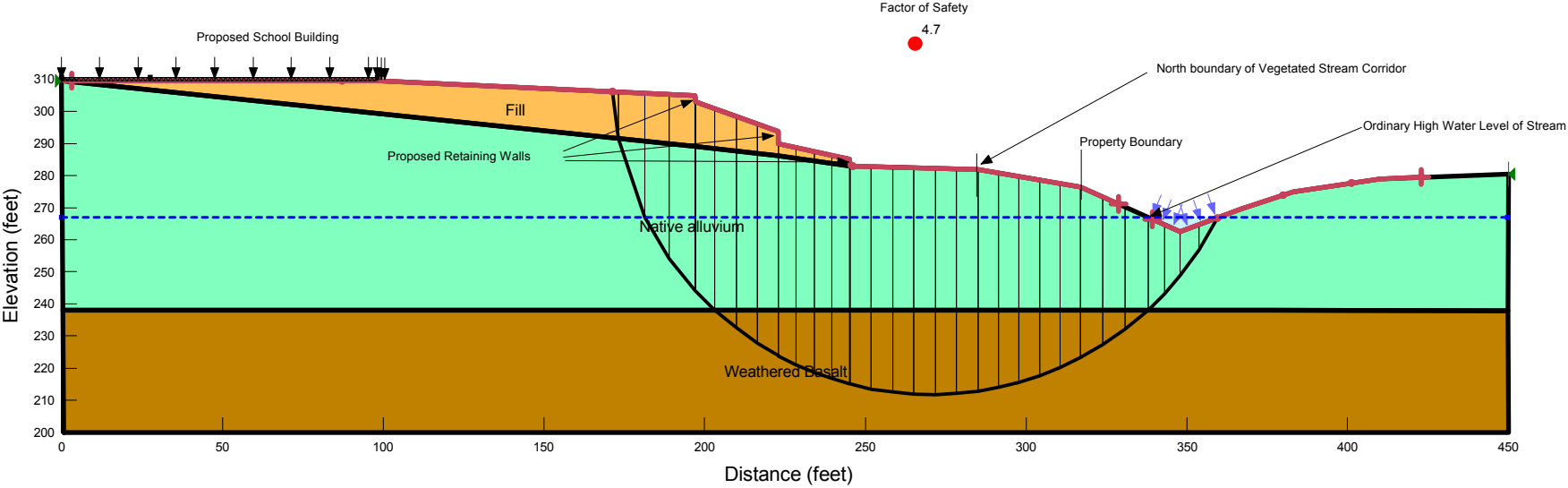
DLR Group  
Architecture Planning Interiors  
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**Kaiser K5  
BeavSchool-49-01  
Section A-A'  
Fill  
Static Conditions**

Name: Native alluvium  
Model: Mohr-Coulomb  
Unit Weight: 115 pcf  
Cohesion': 0 psf  
Phi': 29 °

Name: Fill  
Model: Mohr-Coulomb  
Unit Weight: 115 pcf  
Cohesion': 0 psf  
Phi': 32 °

Name: Weathered Basalt  
Model: Mohr-Coulomb  
Unit Weight: 130 pcf  
Cohesion': 500 psf  
Phi': 35 °



**ATTACHMENT B**

